The science news monthly

SCIENCE DIGEST

AUGUST 1965 35 CENTS ICD

LIFE IN 1990

A vivid preview by Isaac Asimov

Also:

DMSO–medicine's new 'miracle'

How chance affects your life

Did the universe ever begin?

Coming: a cancer breakthrough

Who's accident prone, who isn't

Pictorial Parade

Copter that lands itself

PEOPLE who fly will tell you that handling a helicopter demands a lot of you. A plane can practically fly itself, but a whirlybird calls for constant concentration and co-ordination. Yet helicopters have obvious advantages over planes.

Can we combine the advantages of the two kinds of aircraft?

A former wing commander in the R.A.F., Kenneth Wallis, has designed a new, single-seater version of an aircraft he says bridges the gap.

Recently, he took it up for a test run and showed that he could bring it in for a landing without touching the controls (above).

The aircraft has a free-wheeling rotor instead of a helicopter's powered blades. "If the engine packs up," says Wallis, "then the machine just glides down."

He adds: "It is possibly the safest form of flying there is."

The "mini-copter," as the craft is called, can fly at 100 mph at altitudes of up to 10,000 feet.

Wallis and his cousin Geoffrey Wallis, a garage proprietor in Cambridge, England, have formed a new company to market the autogyro.

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June SCIENCE DIGEST Feature Article

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PEOPLE who read *Science Digest* for the first time often react by saying, "But I didn't know *that* was science!"

They find to their surprise that science can fascinate them, benefit them and transform their outlook—even protect their careers and lives from obsolescence.

If you're reading *Science Digest* for the first time, you, too, may be surprised to see what science encompasses. This month it:

THIS MONTH

- Shows how a matador can make a charging bull stop dead by radio.
- Indicates that we may be able to breathe water as well as air.
- Promises a breakthrough in the war on cancer.
- Proves that man can survive in space with no difficulty.
- Points to personality quirks that make you accident prone.
- Comes close to disclosing how the universe began—if it did.
- Examines precisely the law of averages in your life.
- Projects a life 25 years from now quite different from today's.
- Tests new chemicals that may help cure mental illness.
- Looks hard at a new drug that may become another aspirin.

That's just some of what science has come up with for us to report this month. Read on and see.

—THE EDITORS

SCIENCE DIGEST

This is one way we'll be traveling to work in 1990, says Isaac Asimov in a sprightly, calculated look at life 25 years from now. Fantasy? Well, think how far we've come in the past 25 years. For the full, farseeing story, see page 63.

Painting by Lloyd Birmingham

AUGUST • 1965 VOL. 58, NO. 2

SCIENCE THIS MONTH

SCIENCE PANORAMA

SCIENCE MISCELLANY

THE LATE SCIENCE NEWS

WHEN LIFE BEGAN. Nobel Prize-winning biologist Dr. Melvin Calvin and a team of researchers at the University of California reported having found firm evidence that life existed on the earth at least 2.7 billion years ago. This is 800 million years earlier than the previously known first firm signs of life. The evidence is two chemicals, produced only by clorophyll-containing plants, that have been found in geological strata whose age has been precisely dated. Earlier patterns of what seemed to be primitve algae were found in limestone of a comparable age.

HOW LONG BEFORE? Since clorophyll-containing plants are a fairly high form of life, much simpler forms must have existed even earlier. The age of the earth is now estimated at 4.7 billion years. This means that life began soon after the earth solidified and bodies of water formed, progressing very rapidly after that.

HOW LIFE BEGAN. Another team at the Berkeley campus of the University of California has produced substances vital to the chemical evolution of life in an environment theoretically identical to the early atmosphere of the earth. This had been done before but the amounts of life material produced were tiny. By adding certain substances that must have also been present in the early days, the Berkeley team greatly accelerated the process.

HOW CAPE KENNEDY LOOKS FROM SPACE. NASA released this photo of America's "spaceport" as seen by James McDivitt and Edward White on one of Gemini 4's revolutions over the U.S. Enlarged from a shot made with a hand-held Hasselblad camera, it shows the launch pads along the pointed shoreline, the Vertical Assembly Building for the Apollo moon shots at the three-way intersection, bottom center, and town of Cocoa Beach, top left.

SUCCESSFUL TITAN 3-C TEST. A successful test of the giant Titan 3-C rocket has raised the possibility that the Air Force may get a man-in-space program of its own. The Titan 3-C is a Titan with two solid-fuel rockets bolted alongside. In the test, it generated more than 2.4 million pounds of thrust, making it the most powerful rocket ever launched. The Air Force now confidently expects approval of its proposed manned orbiting laboratory. Although the Air Force has contributed heavily to the civilian manned space program, it has not had one of its own.

NEW CONSTITUENT OF UNIVERSE. Astronomers at the Mount Wilson and Palomar Observatories have announced the discovery of a "major new constituent of the universe" made up of mysterious, powerful objects called "quasi-stellar blue galaxies." Actually these objects have been know for a long time, but astronomers thought they were ordinary stars on the edge of our Milky Way galaxy. Observations now indicate that these objects are fantastically large and brilliant and that they are scattered throughout the entire universe. One of them has been estimated to be the second most distant known object in the universe. In some way they resemble quasars or quasi-stellar radio sources, except that they do not emit the enormous bursts of radio energy associated with quasars and they are more numerous.

BIG BOOST FOR BIG BANG. Dr. Allan Sandage, the astronomer who announced the discovery of the blue galaxies, said, "The clues indicate that our universe is a finite, closed system originating in a 'big bang,' that the expanding universe is slowing down and that it probably pulsates once every 82 billion years." The evidence is still preliminary, but a closer examination of the blue galaxies should solve the question of the origin of the universe within a few years. Astronomers previously thought that the question could be answered by a detailed examination of quasars, but blue galaxies are apparently 500 times more plentiful than quasars and there are an estimated 100,000 of them to be seen (see p.40).

NEW QUASAR PUZZLE. A discovery that may knock all the previous estimates about the size and distance of quasars into a cocked hat has been made by a University of Michigan radio astronomer, William A. Dent. Dr. Dent has observed a surprising increase in the strength of radio radiation from quasar 3C 273. It was an increase of 40 percent over 1,000 days. In two other quasars, 3C 279 and 3C 345, he has detected a decrease of about 20 percent over the past year. According to Dr. Dent, the speed of variation may mean one of two things: Either quasars aren't at the edge of space, or they don't give off radiation the way astronomers think they do. Dr. Dent reasoned that for such rapid variations, quasars must be very small. He questioned whether such small objects are really as far away as believed. If they are not, their enormous red shifts may not be due to an expanding universe.

AUTOMATIC LANDING. A regularly scheduled British European Airways jetliner was landed by computers at a London airport. It was the first time an automatic landing was made with passengers (see p. 32).

COMPLEX ANTIMATTER PARTICLES. Physicists at Brookhaven National Laboratory have produced antimatter particles in a form more complex than ever before in the giant particle accelerator. The results of this experiment show that antimatter can exist in groups of particles. Previously it had only been detected as isolated subatomic particles. The particle produced was the antideuteron.

IS THERE AN ANTIUNIVERSE? The antimatter findings at Brookhaven have raised the real possibility that somewhere there may exist an antiuniverse with antiworlds perhaps populated by antipeople. Antimatter is the reverse, or mirror image of matter as we know it. Dr. Leon M. Lederman, one of the team that discovered the antideuteron, said there is every reason to believe that the same number of particles and anti-particles were created when the universe began. Where an antiworld might be located is not known, he added, and there is no indication that the antiworld mingles with the known universe.

ANTIMATTER EXPLOSION? In theory, when a particle of ordinary matter contacts a particle of antimatter they mutually annihilate each other, with the release of a tremendous amount of energy. Three American scientists have speculated that the mysterious explosion in Siberia in 1908 may have been caused when an antimatter meteor struck the earth.

QUOTE OF THE MONTH: "The realization, during the Renaissance, that the earth is not central to the cosmos deeply affected the creative geniuses of that time. If Dr. (Allan) Sandage's preliminary interpretation of the data is correct, then it is established that the universe is ultimately bound to collapse upon itself. This too will have enormous implications. . . . It is hard to see how they can fail to influence the creative currents of our time." WALTER SULLIVAN, science editor of The New York Times.

Mariner 4 spacecraft was scheduled to provide most spectacular of recent achievements in space. TV camera with reflecting telescope was set to take 25 shots of Mars for transmission to earth after eight-month trip. Soft landing on Mars is planned later.

The exploration explosion

THE exploration of space exploded in a quick succession of events that was enough to make an earthman dizzy.

Major Edward H. White 2d floated in space, maneuvering himself with a "gun" that shot out jets of oxygen. Then he climbed back in his Gemini 4 capsule and completed 62 orbits of the earth with his fellow astronaut, Major James A. McDivitt—without any immediately evident ill effects.

No sooner were they back on this planet than the Russians lofted Luna 6 in a second try within a month at a soft landing on the moon.

It failed this time because a motor used to steer the shot in midcourse would not turn off. But observers foresaw another try soon to beat our Surveyor shot due this fall.

Meanwhile, Mariner 4 ticked off the last of the 350 million miles to Mars, with its camera poised to shoot TV pictures of our fellow planet back to earth.

Not everything in the Gemini 4

flight went according to plan: The on-board computer failed, apparently due to a minor electronic defect, so that the capsule's re-entry was computed from the ground. And a first attempt at a space rendezvous, with the final stage of the Titan II booster, didn't work out. McDivitt was told to quit the attempt when he used up about half his thrusters' fuel to maneuver his ship into position.

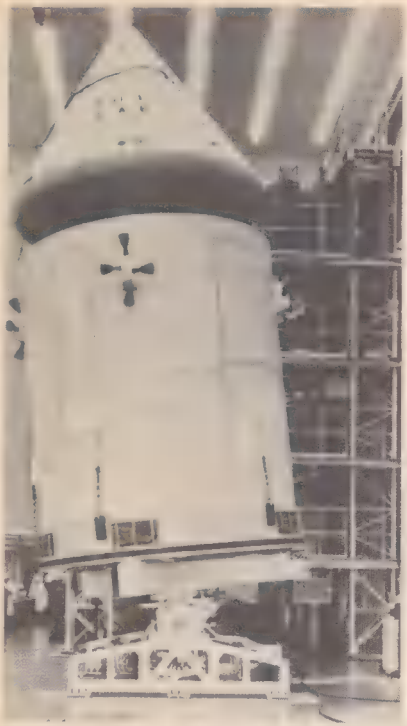
It's expected that both the computer defect will be remedied and the rendezvous capability enhanced by the time Gemini 5 takes off for a seven-day flight this month. That flight will have twice the thruster fuel of Gemini 4 thanks to a fuel cell, to generate power chemically, which will replace the earlier flight's bulky batteries.

Unspectacular but important was the almost perfect functioning of Gemini 4's life-support systems, which kept the capsule's interior as comfortable as a well-airconditioned room, except during White's walk in space. Then the capsule's interior was depressurized, for White went directly through the ship's hatch into space, without benefit of an airlock of the kind the Russians use. Oxygen and temperature control were provided through umbilical lines direct to the astronauts' space suits.

As preparation for the Apollo series of flights, intended finally to place man on the moon, the Gemini

Wide World

Ed White was first man to propel himself in space. He used a gun with oxygen jets.



This is Apollo, craft that'll take man to the moon. Here it's tested on a "rocker."

series' success so far has elated NASA officials. They plan to follow up Gemini 5 with an effort in Gemini 6 to actually lock on an Agena rocket launched an hour and a half beforehand. That will be this fall.

Early next year, Gemini 7 will test how men survive two weeks in space. And at about the same time, the first Apollo flight should be taking off. Perhaps, say space observers, that 1969 deadline for landing a man on the moon will be met.

The big hurdle still to be overcome is the ability to rendezvous

Wide World

Perhaps the most astounding photograph ever made in man's exploration of space shows White's lonely figure orbiting earth at 17,000 mph with Gemini 4 (see open hatch).

with another spacecraft. This is vital to the U.S. moon program because it is built around a plan to have a capsule orbiting the moon while a lunar excursion module detaches itself and goes down to the moon's surface. The LEM must then take off and rendezvous with the capsule to return to earth.

Russia's moon program also calls for a rendezvous—but in orbit around the earth. A second rocket will link up with the moon ship and provide the power for the trip.

Man has a long way to go yet, but he has made a good, fast start.

Beware the drinkers' diet

by Arthur J. Snider

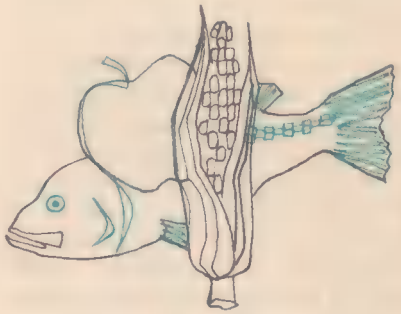
THE newest addition to the food follies is the low-carbohydrate, high-protein, high-fat diet packaged for people who like to drink. Like other diets that emphasize some foods to the exclusion of others, this one can be harmful, contends Dr. Jeremiah Stamler, nutrition specialist in the Chicago health department.

"In eating unlimited amounts of fats and proteins, one is eating high-animal, high-saturated fat," he points out. "This flies in the face of everything we know about the cause of atherosclerosis."

Additionally, a low-carbohydrate diet promotes greater salt loss for reasons not yet understood. The loss of salt and water accounts for a significant amount of the weight drop.

Dr. Stamler's greatest objection to all crash diets is their failure to teach an individual new eating habits which can sustain him throughout his lifetime.

The most effective diet provides all nutrients, protects the patient as much as possible from between-meal hunger and leaves him with a sense of well-being. The diet should be easy to obtain, whether at home or away, without making the dieter feel different. "It should be undertaken in accordance with scientifically sound nutritional principles," Dr. Stamler advises. "This means retaining the basic foods—meats, poultry or fish, fruits and vegetables, bread or cereal, milk or milk products."



In the latest resurgence of diet fads, incidentally, have come the "Mayo diet," the "Mayo egg diet" and the "Mayo reducing diet." But none originated at the famed Mayo Clinic or bears any resemblance to diets in use there. "We are anxious to disclaim any connection with the numerous bizarre diets that are being circulated from person to person in mimeographed form," says Dr. H. N. Hoffman, chairman of the committee on dietetics at the Mayo Clinic.

An estimated 35 million Americans are overweight and an eager fraction of these appear to be in endless pursuit of a painless, quick and easy food regimen that would

enable them to trim the waistline and still keep eating to satiety.

They straw-grasp at every new nutritional stratagem, food formula and miraculous diet offered. Over the years they have gone on the yogurt diet, the wheat germ diet, the egg diet, the orange diet, the corn oil diet, the Hollywood diet, the "Rockefeller" diet, the peaches and cream diet, the meal-in-a-glass diet, the blitz diet and the calories-don't-count diet.

"Now we're waiting for the fruitcake diet, which undoubtedly will be nutty, too," says Dr. Stamler.

The initial loss in crash dieting can be dramatic, but the end result is usually failure because the individuals, either because of sheer monotony or because of a virtuous feeling over having lost 10 or 15 pounds, go back to their old eating habits.

As Dr. Philip L. White, director of the Department of Foods and Nutrition, American Medical Assn., puts it: "Effective long-range weight control is impossible with self-prescribed diets. Most users of such diets are doomed to an on-again, off-again, down-again, up-again paradox of self-treatment."

Dr. Morris Fishbein, who as editor of medical journals has seen crash diets come and go, explains their popularity: "The human being is credulous. Without scientific knowledge, he is easily deceived. He craves easy and enjoyable methods of achieving the difficult objective of weight reduction. Hence, his vanity combined with his credulity makes him an easy victim of those who exploit weight reduction for personal gains."

Along with the diet deluge have come the mechanical methods of girth control, including vibrators, shakers, thumpers and bumpers.

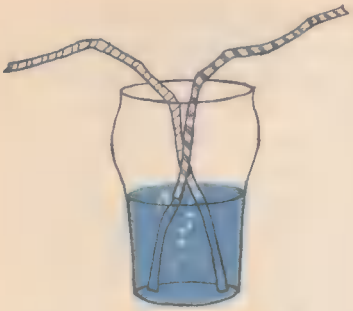
"Phonograph records are available offering quick weight-control methods, but they are nothing but a system of calisthenics," says Fishbein. "Television gets in the act, too, with luscious dames in lascivious poses which are called 'exercises.' Department stores sell distorted rolling pins which are used to roll away fat. Columnists tell hefty women to roll on the bedroom floor, an exercise probably endorsed by the plasterers' union."

While regular and suitable exercise helps maintain physical fitness, it seldom achieves weight reduction in itself. Dr. Fishbein says a diet under medical supervision is necessary.

Kids who don't eat right

Findings in a nutrition survey of more than 2,000 Iowa teenagers show that while the average youngster is well-nourished, a large number are not, even though they live in an area where the supply of nutritious foods is abundant and the economy affluent. They had elevated cholesterol values in their blood. Their gums were swollen and red, their tongues discolored.

Because more and more people in their 30's and 40's are having



coronary occlusions, consideration should be given to the possibility that dietary habits during teenage years are contributing to coronary disease, advises Dr. Robert E. Hodges of the University of Iowa. Teenagers are very inclined to establish eating habits which lead to the repeated ingestion of a limited number of foods.

The survey found examples of the worst possible type of diet in children who come from families in the upper social economic stratum. Many of the children ate no breakfast and lunched on candy, carbonated beverages, pastries or other foods in the "empty calorie" group. The evening meal was the only opportunity for a balanced diet, although the teenagers did not seem to be fond of salads, fresh fruits and vegetables.

News about breast surgery

Progress in the technique of surgery of the breast has made it possible to remove much less tissue than formerly, thus avoiding a deformity of the chest wall in many cases, Dr. Max Cutler, a Beverly Hills, Cal., surgeon reports.

It has been found possible, he says, to take out the glands under the arms without removing the large chest muscle, known as the pectoral muscle, in the upper half of the chest. By preserving this muscle, one avoids any deformity or concavity of the upper chest wall.

"This has tremendous cosmetic significance," Dr. Cutler says. "Women can wear low evening gowns and bathing suits with a perfectly normal appearance. In fact it is exceedingly difficult to know that an operation has been performed on the breast when this muscle is preserved."

Fear of cosmetic deformity is keeping many women away from a breast examination, in the opinion of Dr. W. John Pangman of Beverly Hills. He said there are instances where removal of non-cancerous growths could prevent their turning into cancers later.

In cases where amputation of the breast is required, the use of prosthetic implants can restore appearance. Dr. Pangman discounted fears that the implants may cause cancer.

While tumors have been produced in experimental rats and mice, Dr. Pangman does not believe these studies are valid when applied to human beings. These same experimental animals will often develop cancer from suture materials alone.

"Human beings, particularly soldiers, have carried foreign bits of metal in their bodies throughout

life spans without contracting cancer."

In his own series of 480 implants, still in place after periods up to 13 years, there was only one case of breast cancer and it had no connection with the prosthesis.

Clip that artery

Use of clips is suggested as a more effective method of joining blood vessels than by sewing them together. Dr. Peter B. Samuels of Sherman Oaks, Cal., has devised clips of stainless steel which are non-irritating to the body's tissue.

While the customary suturing technique has proved thoroughly reliable, it is a relatively slow one, Dr. Samuels says. Vital organs must be shut off from their blood supply during the joining of arteries, and speed is essential. The faster the union, the less the risk of damage to organs.

Clips have the added advantage of producing water-tight seams and of not leaving any material in the interior of the blood vessels.

"Presently, these clips are the only mechanical method to be actually used in clinical cases with diseased arteries," the surgeon says. "The Russian staplers, though highly publicized, have only been used experimentally and only in normal vessels." He has used clips successfully in 18 cases to date with no complications.

His interest in clips for joining vessels led Dr. Samuels to the development of a new hemostatic clip for stopping bleeding during general surgery. Under current practice, when bleeding must be stopped, vessels and bleeding points are usually clamped with hemostats and then tied off with thread. As this may have to be done scores of times in the course of an operation, the duration of surgery is added to appreciably. By using tiny clips of tantalum, the operations are speeded up and the patient spared an extra period of anesthesia and exposure of his wounds.

Birth control by vaccination

Research leading to the development of a growing number of vaccines offer the "speculative possibility" that women could be immunized against pregnancy, according to Dr. James G. Telfer of the American Medical Assn.'s department of environmental health.

This possibility also stems from findings that some infertile couples are unable to conceive because of a male-female immunological barrier.

The female eggs sets up immunological antibodies against the male spermatozoa, which it regards as foreign protein, for a reason still unknown.

"Laboratories are working on the possibility of developing the antigen-antibody reaction artificially," Dr. Telfar says. "If such a vaccine were developed, a woman probably would have to be vaccinated about every six months to remain sterile."

Hepatitis breakthrough

For the first time, a monkey has been successfully infected with the virus of human viral hepatitis and has developed a disease identical with that occurring in human beings. This will give researchers a suitable experimental animal for the study of viral hepatitis, a deficiency that has been handicapping research.

The development is reported by Dr. Hans F. Smetana, pathologist-in-chief and director of laboratories, Delta Regional Primate Research Center, Covington, La.

Dr. Smetana points out that while viral hepatitis has been known since antiquity, very little progress has been made in the control and prevention of the disease. There are two forms. One is referred to as infectious hepatitis and is usually acquired by taking contaminated water or food. This disease has occured in every military campaign in history, including World Wars I and II and the Korean expedition.

The other type is referred to as homologous serum jaundice and is mainly caused by transfusion of blood from donors who are silent carriers of the virus. The two types of viral hepatitis are most probably caused by related but not identical virus.

Transfusions we don't need

Without a doubt, a single blood transfusion is the greatest abuse of blood therapy, says the "West Virginia Medical Journal" in an editorial. If a patient can be treated adequately with a single unit transfusion, there is doubt that the transfusion was needed in the first place.

The practice, performed largely to "pep up" patients or to make them "look better" before they go home from the hospital, is not done as frequently as in the past, the editorial points out, because it has been realized there are hazards to every transfusion. Infections such as syphilis, malaria and hepatitis may be transmitted through transfusion. According to the American Association of Blood Banks, one out of every 200 transfusions results in hepatitis.

Only five reasons can be justified for giving blood transfusions, it is pointed out: To maintain blood volume and prevent shock, to maintain oxygen-carrying capacity, to promote and maintain ability to clot blood, to replace blood that has become poisoned, and finally, for use in the heart-lung machine.

WONDER OF THE MONTH

Mammals that breathe under water

An ordinary laboratory white mouse spent 18 hours submerged in a vessel filled with heavily oxygenated salt water (above).

While under water, the mouse actually breathed the water, extracting oxygen from water with its lungs in exactly the same manner a fish extracts oxygen from water with its gills.

Unfortunately for the mouse, when it was removed from the water it died, but dogs have survived shorter periods of breathing water if they were helped in removing the remaining liquid from their lungs.

The Dutch-born scientist who has pioneered these experiments sees no reason why man can't do the same. But don't try to breathe water next time you go swimming, because you will drown. The water that the mice and dogs were breathing was of a very special type. It had a salinity to match that of the animal's lung tissue. It was highly pressurized to make it easier for the animal to inhale and exhale. And, most important of all, the water was heavily saturated with oxygen.

Dr. Johannes A. Kylstra began experimenting with unusual functions for the lung 17 years ago, when he was a medical student in Leiden. At that time, he thought the lungs might be able to take over some of the functions of a diseased kidney.

Now Dr. Kylstra is at the State University of New York at Buffalo, and he has abandoned the idea of using the lung as a kidney; he thinks it would make a much better gill.

Despite his success with having mammals breathe under water, Dr. Kylstra says, "I would not want to try it with a human until a definite need arose for developing this sort of capability."

Of what possible use would breathing liquid be to man? Future space travellers would be better

protected from the shock of a hard landing on another planet if they were suspended in a chamber filled with a liquid they could also breathe.

Liquid-filled chamber

Floating in a liquid-filled chamber is the way the delicate yolk of an egg is protected from shocks and the way the human fetus is protected by the amniotic fluid before birth.

Future skindivers might also make use of the liquid-breathing technique so that they could go deeper, stay longer and come back up faster. But the diver would not be breathing ocean water. His normal breathing apparatus would be replaced by a bag of salt solution, a heating element to keep the liquid warm, a mechanical pump to aid in breathing it and a small tank of compressed oxygen that would be bubbled through the fluid.

There would be two advantages to breathing this sort of liquid under water:

First, ordinary gases become compressed by the increasing pressure as the diver descends. All gases become toxic when they are compressed and the nitrogen in the mixture the diver breathes becomes a danger after a certain point. It produces what is called "rapture of the deep" or nitrogen narcosis in a diver. Because of this effect, free-swimming divers are not able to descend much below 300 feet.

It takes much more pressure to compress liquids than a diver normally encounters. Thus by replacing the gas nitrogen with a liquid salt solution as the oxygen carrier, you eliminate the danger of nitrogen narcosis.

Another disadvantage a diver faces because of nitrogen is the "bends" or decompression sickness. If the diver comes up too quickly, the nitrogen that is dissolved in his tissues bubbles out and produces this painful and dangerous condition. Breathing an oxygen-carrying liquid would not expose a diver to the bends.

At this time, however, Dr. Kylstra is more interested in studying the medical effects of liquid breathing by mammals rather than in devising any practical applications for the effect.

This dog, mascot of a Dutch vessel, survived after breathing water for 23 minutes.

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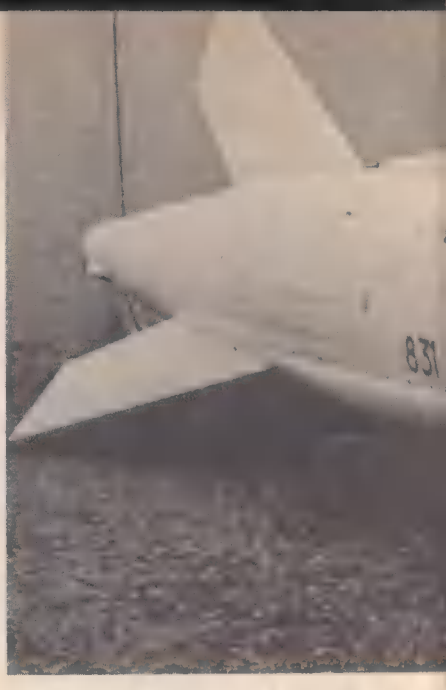
THE NUCLEAR STORY

The A-bomb is 20

In August, 1945, twenty years ago this month, the decision was taken to drop the world's first A-bomb on Hiroshima, Japan. It was a decision that followed perhaps the biggest dispute scientists have ever had. On this 20th anniversary, Science Digest offers: 1. A postmortem of the dispute. 2. A review of the dangers of A-power today.



This is the first picture of the French

by Hubert Pryor

Physicist Leo Szilard of the University of Chicago urged Albert Einstein in the early 1940's to tell President Roosevelt that the United States ought to make an atomic bomb.

Einstein did, Roosevelt agreed and in the spring of 1945, one of the greatest scientific-technological crash programs in history was near completion.

But Roosevelt was dead, an ill-prepared Harry S. Truman was trying to fill his shoes and the war was coming to the end of its six-year blood bath.

The war against Germany was all but over, and Szilard, the man who had started it all, began to ask himself:

"What is the purpose of continu-

Paris Match

A-bomb, a 60-kiloton projectile four times more powerful than the Hiroshima bomb.

ing the development of the bomb, and how will the bomb be used if the war with Japan is not ended by the time we have the first bombs?"

The seed of doubt was sown. It

POST-MORTEM

soon blossomed into a great, agonizing debate among the nation's political and military leaders and, especially, the scientists who had made the now almost completed bomb—a weapon that was to be tens of thousands of times more destructive than the greatest the war had yet developed.

What *were* the views of the scientists? Recently, in an NBC White Paper called "The Decision to Drop the Bomb," the scientists themselves recalled their debate of the appalling alternatives.

The debate began in a shadow world of supersecrecy.

By April 25, 1945, 13 days after Roosevelt had died, Truman still had not been briefed on the A-bomb. Secretary of War Henry L. Stimson recommended that Truman set up a special committee called the Interim Committee to consider the relation of the new weapon to the war against Japan. James Conant, then chairman of the National Defense Research Committee, recalled that the climate of opinion at the time was one "in which everybody almost took for granted tremendous destruction of civilian lives and civilian dwellings and cities."

Debate raged over the proposal to conduct a striking but harmless demonstration of the bomb to persuade the Japanese to sue for peace.

Robert Oppenheimer, who was director of the Los Alamos lab working on the bomb, agreed. He said he believed "that the horror of the war that was on and the horror of the war which military planners expected to continue for a long time was so very great that it was more or less taken for granted that if a new weapon could put an end to this agony, it should be used."

When the Interim Committee met, Secretary of State James F. Byrnes asked Ernest O. Lawrence, director of UC's Radiation Lab in Berkeley, to raise again a question that had been raised earlier in passing—that was that there should be a striking but harmless demonstration of the A-bomb in the hope that the Japanese might be persuaded to sue for peace.

Gordon Arneson, recording secretary of the committee, recalled the discussion, adding: "Coupled with the demonstration, of course, was the possibility that the weapon might have to be used subsequently, if the Japanese were not sufficiently impressed."

The idea was discussed at some length. Oppenheimer said he doubted whether a sufficiently startling demonstration could be devised that would convince the Japanese they ought to surrender. And Conant, recalling the discussion, said, "Remember that none of them had ever seen a bomb go off. We had no idea as to what you could do, or what sort of effect it would have."

There were other difficulties. "If we were to try a demonstration over Japanese territory," Arneson remembered the participants' saying, "the plane might be shot down; American prisoners of war might be brought into the demonstration area. Someone finally said that unless this weapon was used with maximum impact, it might be difficult for anyone to see much difference between it and the fire bomb raids that were going on at that very time over Tokyo."

The Interim Committee decided to make a unanimous recommendation to the President: Use the atomic bomb against Japan without warning.

But as the committee adjourned, one member of the scientific panel had a question. Arthur Compton, head of the Chicago atomic research project, said, "What shall I tell Szilard and the others?"

He was told that he could mention the committee and that it was anxious to have the views of the scientists.

Compton asked several groups to prepare papers, according to Arneson. One of the groups was one that became known as the Franck Committee. Its head was James Franck, of the University of Chicago.

The Franck Committee had its report ready to go to Washington within a few days. One of the signers was Glenn Seaborg of UC's Radiation Lab, but then also in Chicago, who today is chairman of the Atomic Energy Commission.

"Some of the main conclusions of that report," Seaborg recalled, "were that there were no long-lasting secrets of nuclear energy, nuclear weapons—that other nations would obtain nuclear weapons in the not too distant future after the war, and therefore international control was imperative.

"But perhaps the conclusion that was most publicized," Seaborg added, "was the suggestion that the nuclear weapon not be dropped directly upon Japan but that it be demonstrated first on some uninhabited area."

Compton accompanied Franck to Washington to deliver the report, along with a covering letter that Compton had written, expressing reservations concerning the report.

Arneson described Compton's letter: "He said he thought that these recommendations did not take fully enough into consideration the fact that a technical demonstration might mean considerable prolongation of the war; and second, failure to use the weapon in all its fury might make it very difficult for the world to understand what it really was facing and, not understanding what it was facing, might not make the effort that really was needed to see whether we could not get effective international control."

KFS

J. Robert Oppenheimer, director of the Los Alamos lab working on the bomb, felt that it should be used to end the war.

Scientist Leo Szilard started it all, but later urged that the bomb not be used against Japanese without a demonstration.

KFS

Those in favor of dropping the bomb hoped it would save countless lives and put an end to atrocities, concentration camps and air raids.

Before discussing the Franck report, the Interim Committee decided to hear the views of the scientific panel.

Oppenheimer reconstructed the discussion: "I remember that we first responded to the question of what do scientists think by saying they think a variety of things, that this is only natural, that this is not a completely trivial question. We said second that we didn't think that we had before us the kind of insight or in back of us the kind of experience that really qualified us to cope with this decision. We said that there seemed to be [a] great [many] views among scientists and no doubt would be among others if people knew about it.

"On the one hand they hoped that this instrument would never be used in war and therefore they hoped we would not start out by using it. On the other hand they hoped, or other people hoped, that it would put an end to this war, save countless lives, put an end to a butchery that was going on for many years and had been marked by atrocities, concentration camps, murderous raids on cities, Rotterdam and Dresden and Tokyo itself. But on the whole you are inclined to think if it was needed to put an end to the war and had a chance of doing so, we thought that was the right thing to do.

"It is not that we said a test isn't feasible; we said we don't think we would recommend one that wasn't likely to induce surrender."

So the Interim Committee decided to reaffirm its earlier decision to recommend that the weapon be used against the Japanese at the earliest opportunity and without warning.

But by now the battle for Okinawa was over and the Interim Committee's reaffirmed decision prompted still further "second thoughts" among "various scientists and various people who were close to the picture." The quotes are those of Ralph Bard, wartime Under-Secretary of the Navy.

Among those with second thoughts were John J. McCloy, Assistant Secretary of War, and Lewis Strauss, later to be chairman of the Atomic Energy Commission. "It seemed to me," said Strauss, "not only that it was a sin to kill noncombatants, but that if such a weapon could be made it would be better that it not be used in a war which was ending."

There were others who thought the bomb should first be demonstrated. One was physicist Edward Teller, who was working in Los Alamos. "I got a letter from Chicago from my good friend Leo Szilard," he recalled. "He wrote me about the Franck Committee, about

the suggestion not to use the nuclear bomb on Japan without a previous test. Szilard very often caused me to think about things seriously. I did not always agree with him, but on this occasion I felt he was right."

George Kistiakowsky, a physical chemist working on the bomb, said, "There was a great deal of discussion about the unwisdom of using the bomb militarily. Some people suggested we drop a bomb somewhere not far from Tokyo, in the Tokyo Bay area, and some others suggested that we drop one on Mount Fujiyama, just to scare the Japanese."

But would a test have worked? New doubt now stirred among the scientists:

Oppenheimer: "You ask yourself would the Japanese government as then constituted and with division between the peace party and the war party—would it have been influenced by an enormous nuclear firecracker detonated at great height doing little damage, and your answer is as good as mine. I don't know."

Teller: "Oppenheimer told me not to do anything. He told me that neither Szilard nor I, nor the majority of the people at Los Alamos, did have proper and sufficient information to make a decision or to influence a decision (because we certainly could not have made it)—to influence a decision in such a weighty matter."

Kistiakowsky: "The story was that he had seen military intelligence estimates on the course of

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Edward Teller, "father of the hydrogen bomb," agreed with Szilard that the bomb should not be used without a demonstration.

KFS

Glenn T. Seaborg, now chairman of the AEC, signed a report recommending international control of nuclear weapons.

war in Japan, prepared of course without knowledge of the atomic bomb, and that these estimates were that the Japanese were quite unready to surrender, that they would continue waging the war, even though realizing its eventual outcome, until well after we invaded the main islands of Japan in November and that probably a million casualties would result."

Oppenheimer: "I know only that I was told that an invasion was planned, it would be necessary and it would be terribly costly."

Kistiakowsky: "And it certainly had some effect on me and I began to think that maybe under these conditions such an enormously drastic step as a military use of the bomb would be justified to reduce the total number of casualties and end the war much sooner."

Szilard circulates petition

Still, in Chicago, Leo Szilard tried once again to influence the decision. He circulated a petition on which he had some 60 signatures, Arneson recalled. The petition urged that the weapon not be used militarily against the Japanese without a prior demonstration. "This petition," Arneson said, "generated counter petitions."

By now, so many viewpoints were being expressed by the scientists that it was hard to know just what they did think. Brig. Gen. Leslie Groves, head of the whole A-bomb project, asked Compton to conduct a poll of the Chicago scientists, covering the alternatives.

The scientists at Chicago were polled individually, without any discussion. Even today, there is still doubt as to the results.

"There's been some controversy about that poll," Arneson recalled, "whether the questions were clear or not, but Dr. Compton felt that 46 percent of those polled, of I think about 150, felt that the weapon should be used militarily."

But the outcome of the poll was to make no difference.

"The Compton poll arrived in Washington on the first of August," Arneson recalled, "and I think that by that time the issue had been decided. . . ."

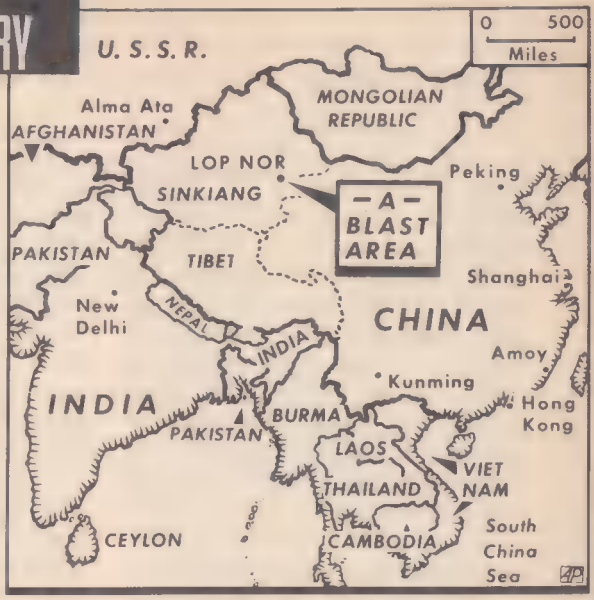
On July 15, in the sands around Alamogordo, New Mexico, an incredible flash had illuminated the early morning darkness, sending a huge ball of fire into the sky. There was no doubt the bomb would work.

Physicist Kenneth Bainbridge, who had directed the test, shook hands with Oppenheimer. "Now," he said, "we're all sons of bitches."

In Potsdam, Germany, where he was at the Big Three meeting, Truman approved the final order to drop the A-bomb.

The day after the bomb order went out, an ultimatum was delivered to Japan. The Japanese decided to ignore it. On August 1, as he left the Big Three meeting, on the same day that the Compton poll arrived in Washington, the President heard of the Japanese decision.

He interpreted it as a rejection. He did not recall the bomb order.



Lop Nor is the site of China's first atomic tests.

China upsets the applecart

by Daniel Cohen

For twenty years, scientists connected with the development of nuclear weapons have worried about what they call "the Nth country problem". This means that if the spread of nuclear weapons is not stopped, N (any number of) countries may be able to develop them and eventually they will fall into the hands of a country irresponsible enough to use them.

If the statements about nuclear war coming from the leaders of Communist China are serious, then the worst fears of the Nth country speculators are being realized. From Chairman Mao Tse-tung on down, the Chinese leadership shows, at least in its public pronouncements, a terrifying ignorance of the facts of life in the nuclear age.

China's position is in some ways predictable. Early in their nuclear careers, both the United States and

PROSPECT

the Soviet Union made some foolishly optimistic statements about their respective ability to survive a full-scale nuclear attack. In recent years, a growing sense of responsibility and possibly fear has led officials of both nations to issue

Mao has stated that China would survive a nuclear war better than any other country because of its enormous and mostly rural population.

much grimmer and, in the view of scientists, more accurate appraisals of what nuclear war would do. Even the bleakest estimates of nuclear destruction can be misleading, because it is impossible to guess how many would die of the starvation and disease that would inevitably follow the destruction of communication, transportation and health facilities. Beyond this, no one knows at what point accumulated pain and misery would destroy a nation's will to survive.

China, however, has gone beyond the early optimism in the U.S. No government has ever issued a statement as dangerously ignorant as what the Chinese Communist party said on Sept. 1, 1963:

Optimistic

"We say that if imperialism should unleash a nuclear war and the worst came to worst, half the world's population would be killed. We are optimistic about the future of mankind."

Now that the Chinese have their own nuclear weapons, do they understand their potential better? Obviously General Lo Jui-ching, chief of staff of the Chinese army, hasn't. He wrote recently that nuclear war will "cause sacrifices and destruction, it will also educate the people."

And Mao has often stated his belief that China, because of its enormous and mostly rural population, would survive a nuclear war better than any other country. Writing in *Life* magazine, nuclear physicist Dr. Ralph Lapp, an expert on fallout, concluded recently that Mao simply doesn't understand the problem of nuclear fallout. Dr. Lapp estimated that a full-scale nuclear attack on China today, using big "dirty" H-bombs, would kill almost half a billion people within a few weeks.

Disease

"Disease would make an unimaginable hell of what life remained," he said.

Even this does not tell the full story. The deadly radio-strontium or Strontium 90 laid down by the fallout would cover all of China's agricultural area and render all food grown there deadly until around the year 2021. "The conclusion is clear," says Dr. Lapp. "China would be destroyed in a nuclear attack."

Dr. Lapp blames part of Mao's misconceptions on our own Atomic Energy Commission which, at one time was so anxious to continue atomic testing that it minimized the dangers of fallout. Actually, the biological effects of fallout are even

more harmful than some of the alarmists believed. The U.S. and the U.S.S.R. realized this when they signed the test ban treaty.

While Dr. Lapp warns that China may be underestimating the power of U.S. nuclear weapons, he also suggests that the U.S. may be taking China's potential too lightly.

Hydrogen bomb

Everyone concedes that China can have a hydrogen bomb within a very few years. China's second atomic test in May indicated it has a bomb that can be dropped from a plane rather than just an experimental atomic "device." Also the fissionable material for the Chinese bomb was U-235 produced in a gaseous diffusion plant. Using this method is making a bomb the hard way. Other countries started their development with cheaper, easier-to-obtain plutonium, but U-235 is essential for going on to the next step, a thermonuclear or hydrogen bomb.

After the hydrogen bomb is produced, there are no unusual technical problems to making it bigger and bigger. China may be able to develop a 100-megaton H-bomb sometime in the 1970's.

Many in the U.S. (and presumably Russia) find comfort in the thought that China is too backward and poor to develop an advanced delivery system within the near future. But Dr. Lapp points out that with a 100-megaton H-bomb, a country doesn't need pinpoint accuracy. A wobbly missile that would get anywhere within hundreds of miles of a target would be enough to cause fantastic destruction. So would a bomb exploded in a ship off the coast.

The hope is, of course, that the Chinese are merely "talking tough" now and that as they develop their weapons system they will follow the path of other nations and gain respect of it. Truculent as they are, the leaders of China are not crazy.

Yet, even if China gains a sense of responsibility, the Nth country problem is still with us. Within four years or less, Canada, India, West Germany, Sweden, Japan, Israel, Switzerland and Australia could produce atomic bombs. At present, these are all stable, responsible countries, but will they always remain so? History is not reassuring. The more countries that have the bomb, the greater the chance that one of them will fall under the control of a madman, as Germany did when Hitler took power.

And waiting in the wings are dozens of other, poorer and often less stable, countries who will have an atomic arsenal within their reach as soon as the admission price to the atomic club is lowered. It is inevitable that cheaper, simpler ways of producing U-235 can be found, especially now that China has shown that a technologically backward country can get the bomb.

Twenty years later, the world has still not learned to live safely with what began at Hiroshima.

THE ELECTRONICS STORY

Communications revolution

EARLY Bird's success in transmitting TV across the ocean has thrown the world's communications experts into a frenzy of activity.

Here are two coming developments that promise to revolutionize communications:

1. Network television would rely for the most part on a satellite to send programs to local stations. Networks would make only minimal use of land lines and microwave relays, now used to link stations up.

2. Local stations would be bypassed completely in some instances. A television viewer at home would get a show broadcast direct to his set from a satellite.

The American Broadcasting Company started it all in May when it asked the Federal Communications Commission for a frequency allocation to a satellite of its own to relay programs to local stations.

It's pretty certain that the Communications Satellite Corporation, which operates Early Bird, will be given jurisdiction. But the idea is a solid one and Comsat itself has said it may invite the aerospace industry to propose systems to implement the ABC idea.

The Early Bird satellite itself has only 245 voice channels (used for telephonic communication), of which 240 are needed for a combined video-audio signal. But ABC's James C. Hagerty, vice-president in charge of corporate relations, recently told *Science Digest* that Hughes Aircraft has plans for two more advanced satellites. One would have 12,000 voice channels; the other, 50,000. (Divide by 240 to figure the TV channels.)

Hagerty added that ABC would file a detailed engineering plan for a satellite of the kind it proposes about the end of July. He said ABC has been consulting with Hughes, who made the Early Bird satellite, on the details. Another consultant is Space Technology Laboratories.

The network satellite idea ABC has been working on would require five channels. Three would be for

regular network shows, which are broadcast simultaneously in the Eastern and Central zones, and separately in the Mountain and Pacific zones. A fourth channel would be for news events and the fifth has been promised to National Educational Television.

The big advantage is economy. Hagerty said the industry today spends about $50 million a year for ground circuits to link its stations. By using a satellite wherever possible, he figured the industry could save 50 percent.

The ABC idea prompted a rash of speculation on other logical extensions of the TV satellite concept. RCA's David Sarnoff said it would take less than 10 years to set up a system for broadcasting programs direct to home receivers from a satellite. He said it would cost no more than it would to buy a major television station.

For viewers, such a notion would be a boon. It would provide nearly perfect pictures anywhere at all, because there would be no interference from surrounding terrain, buildings and other ground-level obstacles. Today, a home viewer could get a signal direct from Early Bird if he wanted to go to the expense of building a special dish antenna. Presumably, however, higher power in satellite transmitters would make costly antennas unnecessary.

Satellite TV also promises viewers more selectivity. There's already talk of 12 TV networks, made possible by reduced costs.

The weather girl may even go out of style if the satellites give us instant shots of our meteorology.

INVENTIONS PATENTS PROCESSES

Now: pea-soup landings

The U.S. Federal Aviation Agency has announced approval of a new flight control system that will permit large commercial jet aircraft to make fully automatic landings when ceilings are only 100 feet and visibility only 1,300 feet. Present airline systems are limited to operation with 200-foot ceilings and one-half-mile visibility.

The automatic landing system, developed by the Boeing Company and the Bendix Corporation, is part of a continuing joint development program which has as its goal automatic all-weather precision landing capability.

The system has proved capable of operating with the standard instrument landing system now installed at major airports with greater accuracy and reliability than present flight control systems.

The system has the pilot in command at all times, with instruments to assure him of proper functioning of his equipment as well as high quality flight path information.

A complete system for automatic landings is made up of an improved autopilot coupler and amplifier computer, two radio altimeters, dual flare computers, automatic throttle control, and improved yaw damper and a complete system monitor.

The sensitivity of the autopilot instrument landing system coupler (an instrument that locks the aircraft's automatic pilot to the instrument landing system beam) will permit a longitudinal dispersion of only plus or minus 500 feet from the intended touchdown point and a lateral dispersion of plus or minus 50 feet from the beam. The equipment also automatically compensates for wind conditions. Each of two radio altimeters provides height-above-terrain signals for the autopilot and the indicator on the pilot's panel.

At an altitude of 60 feet, the flare computer takes control of the plane. Upon receiving the appropriate signals from the altimeters, it puts the plane in the landing attitude and reduces its rate of descent to two feet per second for the touchdown. Upon touchdown, the pilot disconnects the system and takes

control of the plant to make the runway rollout.

The operations of all of the system's components are constantly checked during the final approach by a series of monitors. For example, a monitor unit in the autopilot duplicates the computations made by that unit throughout the descent and flare phases of the approach. The computations are made independently of the autopilot computations and constantly compared. Should there be any difference, the monitor disconnects the autopilot and warns the pilot before any noticeable path deviation can develop.

The cost of installing the system may range from approximately $100,000 to $200,000 per airplane.

Downtown Washington, D.C., can be seen in this aerial photograph taken from a U.S. Navy RA-5C Vigilante jet at high altitude. The area enlarged is a small segment from the single Perkin-Elmer reconnaissance camera film strip shown at right (box).

Hybrid Computer

Two computers at the University of Southern California have been cooperating in a scientific version of make believe. Working together, they can simulate the trajectory of missiles, duplicate the behavior of the human circulatory system, or imitate with great accuracy the flow of products through a chemical processing plant.

Individually, the machines are from completely different families of computers. One is an IBM 1710 Control System, a digital computer, and the other is a Beckman 2132, an analog computer.

Linked together, they are called a "hybrid computer" in which the best features of each machine are blended for the sake of efficiency and speed.

By virtue of its ability to memorize huge quantities of data and follow a predetermined, step-by-step program, the IBM 1710 Control System is given the task of overseer in its relationship with the analog machine. It sets up the problems, feeds the required data into the analog computer and then prints out the answers in readable form.

The analog computer cannot read, write or remember, but it does excel in rapidly sensing actual physical changes. In simulating a problem, it reports its findings not in letters and numbers, but in wavy lines on graph paper or the movements of a needle on a meter.

Auto-exhaust control

Nearly complete control of carbon monoxide and smog-forming hydrocarbons in the exhaust of gasoline engines appears possible through the use of specially designed exhaust manifolds into which air is injected.

This conclusion has been reached by Drs. E. N. Cantwell and A. J. Pahnke of the Du Pont Company's Petroleum Chemicals Division.

Dr. Cantwell pointed out, however, that many practical problems may have to be overcome in the application of these exhaust control devices.

Describing the new technique, Dr. Cantwell pointed out that emission levels in automotive exhaust can be decreased significantly by injecting air into conventional manifolds. But still further reductions in hydrocarbon and carbon monoxide emissions can be obtained, be added, through changes in the shape and size of conventional manifolds.

A novel reactor design, involving internal recirculation of the exhaust gas and the use of shields to reduce heat loss, was developed with the aid of an analog computer and proved to be the most effective of those studied by the Du Pont men.

In automotive engines in the laboratory, emission levels were well below the standards established by the state of California. Cantwell said practical application of the reactors is presently limited.

TV pictures from a record

An electronic system that plays television pictures from a phonograph record was recently announced by Westinghouse Electric.

Along with a series of still pictures, voice and music come from the same long-play disc. The new sight-and-sound system is called Phonovid. Phonovid's sounds and pictures are recorded and played back electronically.

"The record is not just an audio recording that triggers pictures from a slide projector," said Dr. William E. Shoupp, Westinghouse vice-president of research. "Both the audio signal and the video signal are present in the grooves of the record and both are picked up by the phonograph needle."

Up to 400 pictures and 40 minutes of voice and music are present on the two sides of a 12-inch, 33⅓ rpm recording, called a Videodisc. The pictures can be line drawings, charts, printed text, or photographs.

Among the educational uses and other applications for Phonovid, Dr. Shoupp cited: classroom instruction at all grade levels, industrial and commercial training, vocational training, military training and remedial instruction.

Dr. Shoupp described several advantages of Phonovid over existing audio-visual systems such as educational TV, movies and film strips: "Phonovid is portable. The recording is played on an ordinary

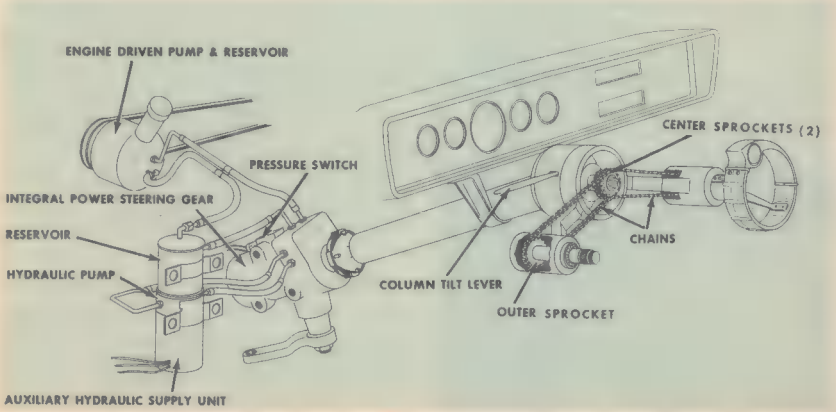
turntable and the pictures and sound appear on any number of television receivers in a classroom or throughout an entire building. Any part of the recording can be held, skipped or repeated by manually lifting the tone arm. Phonovid uses an inherently low-cost, high-density storage medium, the long-play record, in which a large concentration of information can be stored conveniently and in small space."

Wrist-twist steering

The steering wheel concept, which hasn't been altered on cars for more than half a century, may be replaced in the future by an advanced steering control now being tested by Lincoln-Mercury. The new device, which is called "wrist twist" instant steering, not only improves steering but also permits the driver's hands to react swiftly to any other tasks required to control the car. The new steering

control occupies minimum space in the driver's compartment, thereby contributing to improved comfort and vision.

The "wrist twist" controls are two plastic rings five inches in diameter. They are mounted on a tilt steering column. The small rings turn simultaneously and are manipulated easily with one or both hands by a twist of the wrist. A comfort feature of the "wrist twist" system is the addition of arm rests for both controls. The arms can be fully supported during driving, while the hands are placed on the rings.



INVENTOR OF THE MONTH

The box that won a U.S. patent

A TRAVELING showcase, invented by a shipping executive, is now displaying American goods at fairs in many countries.

The invention, an aluminum box 20 feet long, [redacted] feet wide and 8 feet high, has four display booths on each side. The front and back panels are raised to show the merchandise and to serve as canopies (below).

The *Science Digest* Inventor of the Month is Christopher Betjemann (left), vice-president for trade promotion of American Export Isbrandtsen Lines, New York. He wears another hat as president of Mobile Trade Fairs, Inc., a non-profit organization in which the Grace and Farrell Lines also participate.

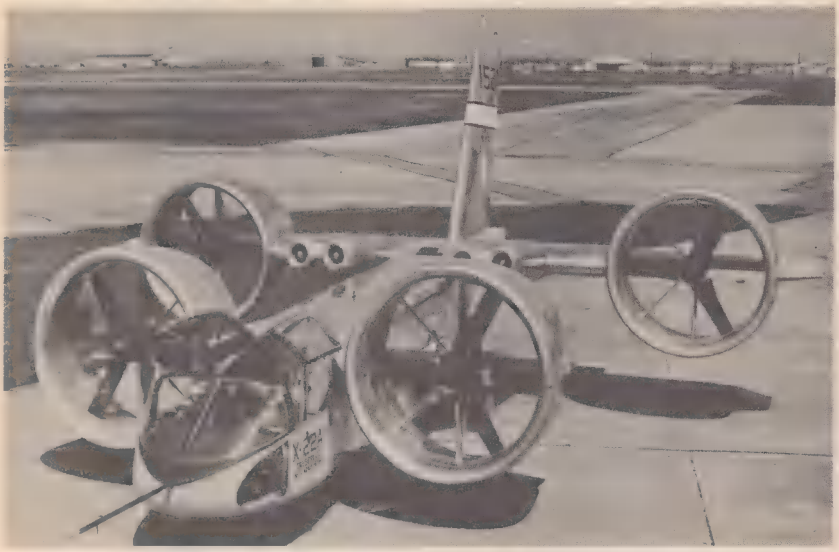
The combined shipping container and showcase, conceived in 1959, attracted the attention of both industry and government. In fact, it led to the federal Mobile Trade Fairs Program, authorized by Congress in 1962.

Manufacturers install their exhibits in this country, and the loaded boxes are lifted aboard a merchant ship. From a foreign port they are transported to the fair grounds.

At the time Mr. Betjemann's recent patent (3,182,424) was issued, groups of the showcases were exhibiting American automotive and service station equipment to prospective buyers in Milan. They were later to be transferred to Turin, Genoa, Beirut, Istanbul and Lisbon, and from there to ports in South Africa and South America.

On the schedule for early summer were displays by about 50 manufacturers of scientific laboratory apparatus, to be sent on a tour of Northern Europe, the Mediterranean and the Far East. The same itinerary was set for displays of industrial instrumentation and controls, beginning in August. —*Stacy V. Jones*

Plane that flies on rings



ONE of the oddest planes ever built (above) is now being tested by the Bell Aerosystems Co. of Buffalo, N.Y. It is called the Tri-Service X-22A, a vertical short takeoff and landing (V/STOL) research airplane.

From now until April, 1966, the X-22A will be run through a broad series of tests. Then two research models will be delivered to the Navy.

For takeoff, the four ringed or ducted propellers are rotated to a vertical position. As altitude is gained, they are gradually swung to a horizontal thrust position. The rings also serve as wings to provide lift during flight.

The plane's four T-58 turboshaft engines are interconnected directly to a cross shaft driving the two rear propellers. A longitudinal shaft carries power to the forward gear box and a cross shaft connects the two forward propellers. This system provides a built-in safety feature. If three engines should fail, the fourth could drive all four propellers to keep the craft airborne.

The Navy is interested in the plane because it is designed to be practical for shipboard operation and below-deck storage.

THE PSYCHOLOGY STORY

Radio-controlled bullfight

By means of a hand-held radio transmitter, Dr. Jose M. R. Delgado of Yale University stops a charging bull. Experiment tested various ways of controlling the brain externally.

A YALE scientist, armed only with a small radio transmitter, stopped an angry bull in midcharge and made it turn around and trot docilely away.

The bull's behavior was controlled by radio signals that produced electrical stimulation of certain regions of the brain, in which tiny wire electrodes had been painlessly implanted the day before.

This strange bullfight was conducted a year ago in Cordova, Spain, by Dr. Jose M. R. Delgado of Yale University's School of Med-

icine. In a recent lecture, Dr. Delgado noted that the bull experiment was only one, although the most spectacular, of a series of demonstrations that he has been working on for the past 15 years. Their purpose: deliberate modification of animal behavior through external control of the brain, to explore the biological basis for emotions, personality and behavior in animals as well as man.

Biological basis

"I do believe," Dr. Delgado said, "that an understanding of the biological basis of social and antisocial behavior and of mental activities, which for the first time in history can now be explored in a conscious brain, may be of decisive importance in the search for intelligent solutions to some of our present anxieties, frustrations and conflicts."

Experiments in modifying behavior by means of electrical stimulation of the brain go back as far as the 19th century, but they were not done extensively until the early 1950's. Today Dr. Delgado is still one of the few who have been using brain stimulation to study social behavior.

Although Dr. Delgado has been able to make electrically stimulated animals walk, fight, eat and go to sleep on command, he has found that in social situations they do not respond like mechanical toys.

For example, a monkey electrically stimulated to act aggressively will not attack other members of the monkey colony at random. Experiments have shown that such monkeys will make only "intelligent" attacks on those competitive members of the colony, ignoring passive or friendly monkeys.

In another experiment, cats or monkeys are stimulated into a set pattern of behavior in which an animal might, for example, run to a corner, turn around, climb up a wall and jump down again and return to where he began, repeating this pattern in the same order every time the right stimulation is applied. But the electrically controlled subject will modify the pattern if other animals get in the way or if he is threatened.

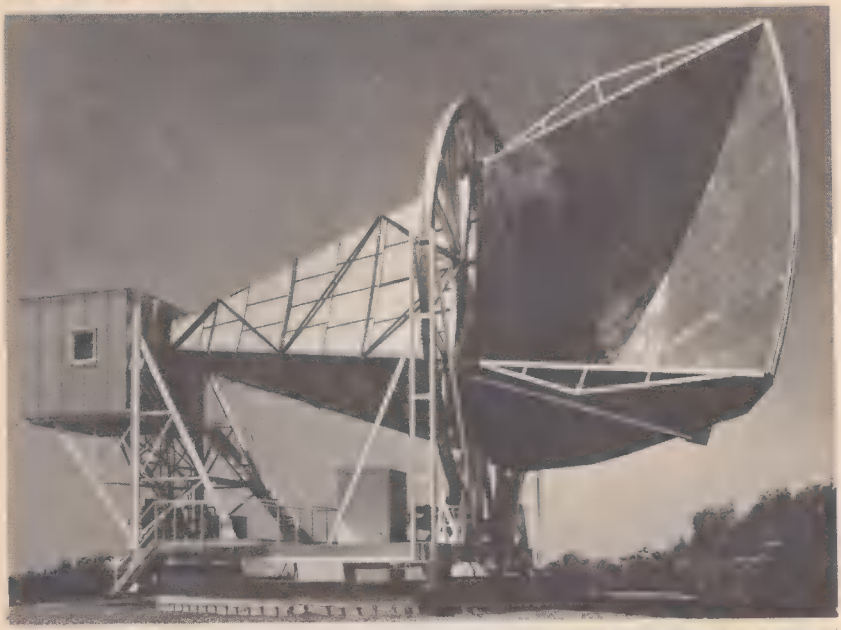
Working with a colony of monkeys, Dr. Delgado was able to stimulate one member of the group to a rage. He then taught other members of the colony to press a button that would calm the enraged monkey. This indicated that animals can be taught to control one another's behavior.

Dr. Delgado and others have also conducted experiments on human beings, primarily during the treatment of certain types of epilepsy. In some cases, electrical stimulation of selected areas of the brain have produced feelings of friendship and anxiety.

The Yale neurophysiologist feels the techniques that he and others are developing will help close the "gap between our understanding of the atom and our understanding of the mind."

THE ASTRONOMY STORY

Did the universe ever begin?



The "ear" of the most sensitive radio receiver yet built, this horn-shaped antenna at Holmdel, New Jersey may be hearing the remains of the birth pangs of the universe.

by Daniel Cohen

For man, living out his tiny lifespan on an infinitesimal speck of cosmic dust, the origin of the universe has always been a cause for wonder and speculation.

Is it eternal or did it have a beginning, and if so, when? Man has never lacked for ideas on the question, but evidence to support them lay billions of light years away in space and billions of years back in time.

Within the last fifty years, and particularly within the last three years, man's isolation in a corner of the universe and in a brief moment of time has been broken. Astronomers have developed the eyes to see light and the ears to hear sounds coming from the very edge of the universe, and in a manner of speaking, to look far back and listen into time itself.

Now there is a good possibility that questions about the origin of the universe that have puzzled man since he began to think may very shortly be answered.

The underpinning for the two most popular cosmological theories is the red shift of light. If an object is speeding away from an observer, the light waves from it are lengthened or, as scientists put it, shifted toward the red end of the spectrum. A generation ago, astronomers discovered a shift toward the red in the light reaching us from distant galaxies (systems containing billions of stars) and that the farther away the galaxy, the greater the red shift. The conclusion from this was that all galaxies are moving away from one another, and the farther away they are, the faster they are going. The picture this immediately brings to mind is particles blown apart in an explosion.

Big bang theory

Not surprisingly, one theory on the origin of the universe is known as the big bang theory. According to this theory, all the matter of the universe was bunched up in a single primal atom. Then some 10 to 15 billion years ago, an explosion sent portions of this primal atom scattering in all directions. These portions of matter later formed into galaxies, but they kept speeding away from one another. This theory envisions an "open" universe expanding into infinite space.

A refinement of the big bang theory is the idea of an oscillating universe. In the oscillating universe there is a big bang every 82 billion years or so. The galaxies fly apart up to a certain point, then they fall back together again reforming the primal atom and getting ready for the next big bang. This presents a picture of a "closed" universe.

Right now, supporters of the big bang or oscillating universe theory are very much on top as the result of a remarkable coincidence. Astronomers at Princeton University led by Dr. Robert H. Dicke, professor of physics, estimated that if the universe had begun in an explosion, some remnants of the original flash must still be detectable. By now the waves would have been lengthened by the expansion of the universe so that they would no longer be detectable as light or X-rays but as radio waves. Radio waves and visible light are merely different wavelengths of the electromagnetic spectrum (see *Science Digest*, June, '65). Dr. Dicke and his colleagues calculated the frequency of these "birth sounds of the universe."

At about the same time, Drs. Arno A. Penzias and Robert W. Wilson of Bell Laboratories were trying to get rid of mysterious radio noises they were constantly getting with the sensitive receiver that has been used for picking up signals from the Telstar communications satellite. The receiver is the giant horn antenna at Holmdel, N.J. In recent years, Drs. Penzias and Wilson have been trying to "clean" the system of inherent noise so it could detect satellite signals more clearly. Much of the noise in the system they could explain. Some came from the system itself, some from the air and a small amount

Tiny dot marked by arrow is 3C-9, most distant known object in the universe.

from our own galaxy, the Milky Way, and other galaxies. But there was always an unexplained residue. They took the giant antenna to pieces and machined and tested all the parts, but when they put it back together again, the noise was still there.

Radio noise

Now, all bodies with a temperature above absolute zero give off some radio noise. Thus radio noise is measured in terms of the power given off by a black body at a given temperature. The residual noise observed by the Bell scientists was 3.5° Kelvin (or 3.5° above absolute zero).

Without knowing about the Bell men's work, the Princeton group, in the meantime, had predicted that the noise from the big bang would be about 10° Kelvin. Scientists consider the two figures quite close.

The coincidence promises a great deal more investigation of the big bang theory. The Princeton group has already built its own antenna.

Rivaling the big bang theory for popularity is the steady state theory. This holds that as the universe expands, new matter is created to fill in the gaps. New galaxies replace those that have sped outward so there is always the same number of galaxies in a given volume of space. Thus the universe has remained in the same state for an infinite time and will remain so for an infinite time. (The theory does not speculate on how the new matter is created any more than the big bang or oscillating theories try to explain the origin of the primal atom.)

The steady state theory is now seriously challenged by the noise picked up with the horn antenna. Nothing in the steady state theory accounts for such signals.

This one finding, however, will not settle matters between the rival cosmologies. Bell's Dr. Wilson says, "When you get into the field of cosmology, all bets are off, because you can trust cosmologists to come up with an explanation for anything in time."

More convincing evidence will accumulate when astronomers get a good count of those strange celestial objects known as quasars (quasi-stellar radio sources). Originally, quasars were thought to be ordinary stars within our own galaxy. In 1960, it was discovered that they emitted energy as radio waves as well as in the form of light. In

1963, Dr. Maarten Schmidt, an astronomer at the California Institute of Technology, found that one of them, known by the catalogue number 3C-273, has an enormous red shift, indicating that it was an object far beyond our galaxy.

Quasars

Although they appear only as faint stars of the 17th or 18th magnitude, if the red shift has been interpreted correctly, the quasars must be the brightest things in the universe, perhaps 100 times brighter than an entire galaxy. Thus they can be observed much farther away than any other objects. Little is known about their energy producing mechanisms, but according to Dr. Schmidt, "there are no indications that the composition of the extremely far away ones is different from that of other quasi-stellars."

Since 1963, the red shift on a few other quasars has been determined, and just recently, Dr. Schmidt has found five quasars that are farther away than any other known objects in the universe (see *Science Digest*, July, '65).

The most distant of the five, 3C-9, is so remote that it appears to be receding from the earth at 80 percent of the velocity of light, or at 149,000 miles a second.

"The light we now see from 3C-9 left it many billions of years ago, before the sun and the earth were born and when the expanding universe was only a third as large as it is today," says Dr. Schmidt. "The light we see from 3C-9 started from it only a few billion years after the universe was born.

"Although all five quasi-stellars are many billions of light years away," he explains, "their exact distances cannot be stated because that would require accurate knowledge of the evolution of the universe. What we have are their relative distances."

At distances over a billion light years, the relationship of the red shift to distance is uncertain because the unknown geometry of the universe may affect this relationship.

The quasars themselves probably no longer exist, having burned out perhaps after a million years of violent life, long before their light reached earthbound telescopes.

Now what does all this have to do with finding the origin of the universe? In the past, astronomers felt that the answer to the question could be determined by counting the number of galaxies in a given volume of space. Each major theory predicts a different distribution of matter. But the difference would become apparent only at very great distances. Since the light from distant galaxies is very dim, astronomers have not been able to count enough distant ones to detect any significant difference.

With the discovery of quasars an entirely new element has been added. Since they can be seen at such fantastic distances, differences in distribution may show up very well, despite the fact that our knowledge

of them is meager. Perhaps knowing the distance of 100 quasars or less will be enough to prove one or the other theory of the universe.

Dr. Thomas Gold, chairman of the Cornell University astronomy department, thinks that if quasars prove to be most densely distributed at the greatest distances, that will show that the universe was once more densely packed, thereby supporting the big bang theory.

Obtaining the red shift of a quasar is exceedingly difficult. So little of the ancient light reaches the earth that there isn't much left to split into a spectral pattern of lines, each representing a specific wavelength of light. This must be done to ascertain the red shift. Dr. Schmidt had to make exposures of four to five hours with the big 200-inch Mt. Palomar telescope to obtain the faint tracings. Interpreting the spectral lines was even harder.

But Dr. Schmidt thinks things will move much faster now. "I believe the red shifts will be determined shortly for many more of them (quasars) because we now know what to look for."

How long will it be before astronomers have information on enough quasars to determine the origin of the universe? Perhaps two or three years, perhaps less than a year. Not long to wait for the answer to a question that is billions of years old.

Venomous babies

THE handful of snakes above is part of a record-breaking brood of 28 Australian tiger snakes, born earlier this year at Australia's Royal Perth Hospital. They are the first of their kind ever to be born in captivity.

These savage, fearless snakes are among the 10 most venomous in the world. The neurotoxin content of their venom is 10 times more potent than that of the Indian cobra and 40 times stronger than that of the Texas rattler, which is deadly enough. In Australia, they are second only to the taipan in venomous deadliness.

The tiger snake is born with all its venomous properties but it is safe to handle while it is still very young because its fangs, through which the venom enters the victim, are not yet strong enough to penetrate human skin. But after the tiger snake is six weeks old, its fangs are big enough, and it is quick to strike and difficult to frighten off.

The line of research on which these venomous babies are destined to spend the rest of their lives deals with the transmission of viruses from lower animal to man.

Although two of the baby snakes have been killed by accident, they do far better in captivity. It is established that 95 percent of all snakes born in the wild state succumb in infancy to a variety of predators—not the least of whom is the father, who is not above making a meal off the family.

One of the captive brood nearly went the same way in an act of perhaps unpremeditated cannibalism by a brother (or sister—nobody can be too sure at this stage).

Two small snakes had fastened to each end of a small frog and were proceeding to eat it. When they met at the middle, the quick-thinking member of the pair opened his jaws—in snakes a remarkable mechanism capable of immense expansion—and continued with the second course.

Fortunately the crime was detected and the slow-thinker extracted before he (or she) suffocated.

TIPS AND TRENDS

NOW IT'S HYPERSONIC AIRCRAFT. The supersonic transport is still years away, but aeronautical experts are already thinking of aircraft that fly many times faster. With hydrogen as a fuel, the Air Force's Gen. B. A. Schriever says, hypersonic craft could fly at 7,000 miles an hour, four times as fast as SST's. And SCRAMJET (supersonic combustion ramjet) would permit sustained, economical flight at up to 17,000 mph.

REMEDY FOR THE SONIC BOOM. That's the promise of a fuselage design change indicated by experiments in a NASA wind tunnel to cut down the "claps of thunder" SST's cause. By making the fuselage bigger in front of the wing, the researchers have altered the air flow. The boom's still there, but softer.

DON'T LOOK FOR FEWER SUDS--MUCH. The new detergents being used exclusively from now on for washing products are "softer," but barely so. Fifty percent of the old detergents could be broken down by bacteria, 50 p.c. couldn't. Thus the suds in our rivers and streams. But barely more than 60 p.c. of the new detergents are broken down, even though a 90-p.c. figure is advertised under ideal conditions. Really "soft" detergents, it's said, are too costly at today's prices.

ATOMIC POWER BREAKS THE COST BARRIER. For the first time, say British officials, costs of electricity from nuclear energy have been brought below those of power from conventional generating stations, ½¢ per kw hour.

BEWARE LASER DAMAGE TO THE EYES. Optical experts have issued that warning to electronics researchers. Laser rays can cause coagulation of the retina in a split second.

WHAT EARLY BIRD'S BEING USED FOR. The communications satellite that is making trans-oceanic TV a commonplace is also being used by IBM for an international data-processing system and by ITT for Videx, which transmits images over a voice-grade channel, and for a 2,000-words-per-minute Teleprinter. Early Bird's also a telephone/telegraph link.

TRAINS THAT TRAVEL 350 MPH. The New York Central envisions such speeds in research work at its Cleveland Technical Center. One possibility: tunnels with low air pressure to duplicate the lack of air resistance encountered by high-altitude planes.

SCIENCE ATTACKS HURRICANES. This hurricane season, weather experts are making another effort to strike at the deadly windstorms before they strike at us. Twice before, in 1961 and 1963, they seeded hurricanes at sea with silver iodide. The crystals tend to collect moisture and freeze it, thus drawing heat energy from the storm. The energy taken from the 1961 hurricane equalled the explosive force of 175,000 tons of TNT. In the 1963 experiment, one pass by seeding planes duplicated that result, another didn't.

THE "INNER SPACE" RACE WITH RUSSIA. We're still ahead in oceanography, but the Soviet Union is catching up. Oceanographer Dr. Robert S. Dietz says we have 1,500-2,000 people in the field; Russia has 1,200.

How to use LSD

by Flora Rheta Schreiber and Melvin Herman

THE value of LSD-25 has been one of the most fiercely discussed topics in contemporary psychiatry.

Some researchers claim that the drug has no real value is diagnosis and little use in therapy, and they say it is dangerous in the hands of unskilled users. A widespread black market exists in the United States, it is said, and kick seekers on campuses and city streets have been confronted with emerging traumatic material due to preexisting symptoms from either the present time or from distant periods of their lives. High doses have evoked psychotic episodes, stupor and catatonic states. Even as long as two years later, psychotic effects are possible. There also is the danger that tendencies and abnormal behavioral leanings will become greatly intensified.

On the other hand, there has been universal interest in LSD (lysergic acid diethylamide). At the Second International Conference on the Use of LSD in Psychotherapy, held in May, under the auspices of the South Oaks Research Foundation, researchers came from nine countries to report on studies that had been going on for many years. Thirty-two papers were delivered at the forum, which was arranged by Dr. Harold A. Abramson, Director of the Foundation, Dr. Frank Fremont-Smith, conference chairman and Director of the Interdisciplinary Communications Program, New York Academy of Sciences, and Dr. André Rolo, Medical Director of South Oaks Hospital.

One of the LSD exponents, Dr. Stanislav Graf of the Psychiatric Research Institute in Prague, Czechoslovakia, told the meeting that using LSD is like putting the subject under a very intense magnifying glass.

Conference on the use of LSD was held at South Oaks Hospital, in Amityville, N. Y.

A small dose of LSD has the power to intoxicate the imbiber and at times to convert his daydreams and fantasy life into visualized patterns, forms and pictures in which his innermost wishes are fulfilled.

But it goes deeper. Under the influence of the drug, the user often unmasks deeply buried facets of his personality that normally are not discernible or that he may have tried to hide. Even his superficial social behavior becomes revealing.

In addition to this, the reactions are highly individual, reflecting one's most important problems and having close connection with his past and present life situation. To quote Dr. Graf, "The intoxication provides a selection between important and less important events from the point of view of emotional life. The symptoms of the intoxication express in a condensed and overdetermined form the key problems. The associations to these symptoms lead in a very short way to the most relevant material."

When combined with psychotherapy, the participants at the conference agreed, LSD is an unrivalled tool for exploring profound and hidden recesses of the human psyche.

Professor Loretta Bender, M.D., Director of the Child Guidance Clinic, New York City, reported definite success in the treatment of schizophrenic children after one month of daily administration of LSD.

In the treatment of alcoholics, according to Humphrey Osmond, M.D., who worked in both Canada and the United States, LSD has a good short-term effect. He even reported success with hard core alcoholics off skid row. Dr. Osmond said that the frequent association of LSD-25 "with the black market and illegal activities such as drug-pushing" was disturbing to the group of alcoholics with whom he had been working.

Dr. Fremont-Smith pointed out that LSD has been a concomitant of successful psychotherapy in the

hands of many doctors in different parts of the world working with the most difficult patients, and in short-term therapy. Dr. Fremont-Smith warned, however, that LSD should be administered only by an extremely competent and confident physician in a hospital.

LSD, it was emphasized and reemphasized, is best used in connection with psychotherapy either individually or in groups. Dr. K. E. Godfrey of Topeka, Kansas, said that the setting in which the treatment is given is probably the most important single element. He said warmth, friendliness and confidence are most effective.

Dr. A. Joyce Martin of London, England, said that the patient-physician relationship is important. The patient must be at ease to reduce resistance. The physician must fulfill the role called upon by the patient "to strengthen the patient's ego and allow him to face up to his hitherto unresolvable conflicts." Dr. Graf spoke of an environment to which his patients respond by saying that they come for the first time in their lives into a milieu that accepts them.

A patient, it is clear, should be properly prepared by psychotherapy before taking LSD. Otherwise he may experience deep depression, massive anxiety, feelings of superfluousness, and paranoid perceptions. Under no circumstance, it was cautioned, should LSD be used to disguise a psychiatrist's failure with a patient who for one reason or another does not make progress in psychotherapy.

One of the questions asked at the conference was: Why do patients under LSD feel they have improved? The answer was because they have better understanding of their problems. This was followed by the question: Why do doctors feel their patients have improved? The doctors said the patients have truly gained emotional insight.

Extra pharmacological factors

To add to mystery, Dr. Graf believes that "the extra pharmacological factors . . . play an extremely important part in the LSD reaction." Not only do the therapist and his method of handling the patient contribute to the LSD reaction, Dr. Graf contends, but also psychotherapy causes patients to be interested in LSD by generating a desire to explore one's mind. The intoxication, he finds, is deeply influenced, too, by the personality of the experimenter.

Much depends on the personality of the patient. There is in fact a galaxy of widely different individual responses to LSD, depending upon a patient's capacity to empathize and his tolerance. Some have optical disturbances; others, unpleasant physical symptoms, even excruciating pain. Still others put up such staunch resistance to

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Miss Schreiber is an award-winning writer on psychiatry; Herman, the Executive Secretary of the National Association of Private Psychiatric Hospitals.

the drug that they have little or no reaction even to a relatively high dose. Women show a greater sensitivity to the effects of LSD than do men.

Depressed patients become more depressed or alternate between depression and euphoric laughter. Obsessive, compulsive and phobic patients, afraid in advance, put forth "a fierce fight" against the effects of the drug and make an extreme endeavor to maintain self-control. "Hysterical patients experience rich optical phenomena, a veritable gallery of swiftly colorful and scenic pictures." The obsessive, compulsive and phobic patients, however, undergo practically no disturbance of optic perception, but do "complain about alarming loss of touch with reality and negative ethical self-estimation and fatigue."

Those who resist LSD also typically resist the effect of liquor, chronic fatigue and sleep deprivation. Fearing any confrontation with the less placid aspects of their personalities, they assiduously avoid all situations that bring to the surface their aggressive and sexual tendencies. To such persons the disinhibiting effects of LSD naturally become a clear and present danger.

When LSD works, it's often in response to questions by the physician. He may ask: Have you ever seen or experienced anything similar to this? Could it have some symbolic meaning? Do you find a relation to your life history? The patient's interest is focused in the searching and he often interprets for himself, tracing his problem back to his original causes and understanding its history.

LSD is one of a commonly used group of drugs, ergo alkaloids, known to physicians for years, that produce hallucinating states which often resemble schizophrenia. Of all the drugs that act on the mind, LSD acts in the smallest dosage. It can be used intravenously, muscularly or by mouth. Many of the reports made at the International Conference, if confirmed by further research, will prove to be outstanding advances in psychiatry.

Adolescent egos

Dr. E. Pumpian-Mindlin of the Department of Psychiatry, Neurology and Behavioral Sciences of the University of Oklahoma School of Medicine, Oklahoma City, Oklahoma, takes note of a particular facet of the development of the ego during the period of late adolescence (roughly from 16 to 22) which has previously gone unnoticed. The doctor designates this aspect of development "Omnipotentiality."

An essential and vital element in the maturation of certain aspects of ego development, this concept relates particularly to the growing concept of the "self." Filled with self-importance, the youth in this phase is convinced that he can do anything in the world and solve any

of the world's problems. Nothing, he feels, is impossible; nothing can be taken for granted. He can assay wild imaginative flights, soaring speculations, incredible adventures. Admitting no limits in fantasy, he can only grudgingly accept limits in reality itself.

At the same time, however, mastery does not come easily. For once he does one thing and follows it through to completion, he has closed doors to other things that challenge him equally. This he is not yet prepared to do.

The commitment, which comes with the next developmental stage, the transition to young adulthood, represents the acceptance of limitations (both external and internal), the acceptance of the fact that one must forego one's omnipotentiality in order to acquire a particular skill or accomplishment.

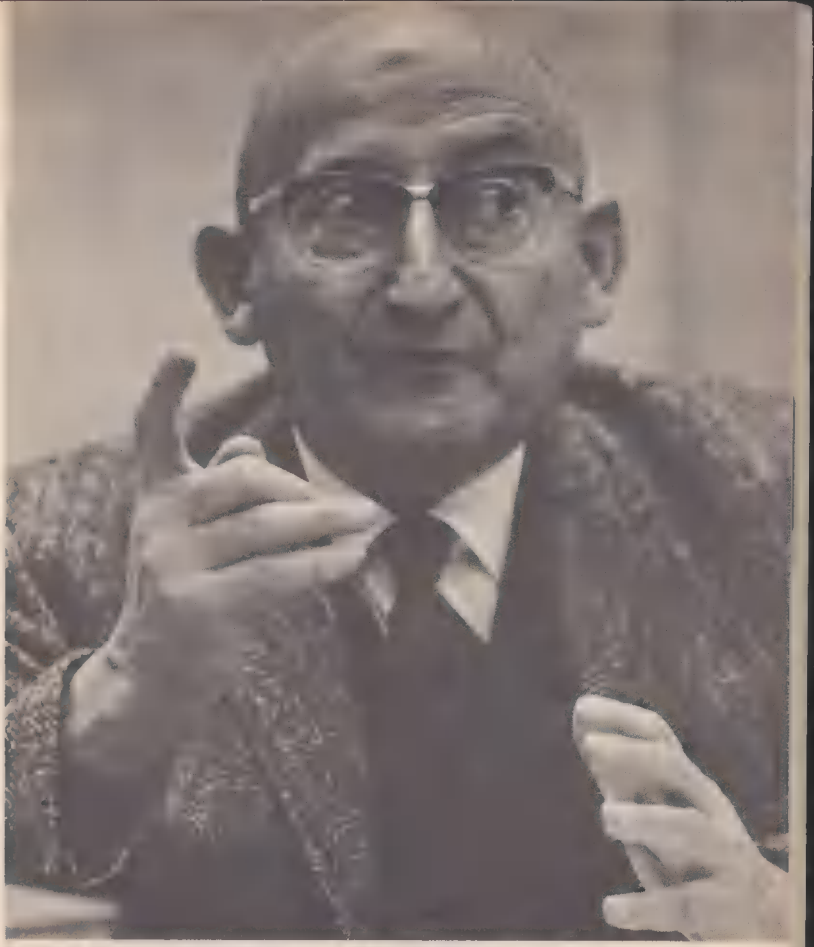
The resolution of omnipotentiality, so vital to maturity and vocational adjustment, comes about, in the normal, healty youth, through the "acting out" of the omnipotential fantasies in reality. Gradually, as they are tested and retested against reality, the diffuse omnipotential energies are channelized to modify the omnipotential fantasies in accord with the demands of reality. Only then can the youth establish his own priorities and commit himself to a specific task.

Adults often find it difficult to accept this omnipotentiality of youth, which makes them feel anxious and jealous, representing as it does a lost dream, the "closing of the doors of the prison house upon the growing boy" (as Wordsworth put it). This unrecognized, unresolved anxiety in the adult is rationalized both socially and individually; it manifests itself in the everlasting complaints against the rashness and folly of the younger generation, and more seriously in repressive measures which take the form of narrowing and restricting the opportunities for expression of these impulses by the young. The perennial conflicts between the generations occur when adults demand the very commitment that the young are not prepared to make. Reacting negatively, youth grows rebellious, acts out its resentment in various forms of antisocial behavior.

The price of adoption

Children adopted in early infancy have neither more nor different behavior problems from children reared by their own parents.

This verdict, deriving from studies made by Drs. Michael Humphrey and Christopher Oumsted of Warreford and Park Hospitals, Oxford, England, does not apply equally, however, to children adopted after the age of six months. Such children were found to be slightly more prone to anti-social conduct than children living with their natural parents.



Dr. Hans Hahn estimates that about 25% of all people are accident prone.

Are you accident prone?

by John Fetterman

"JA," the professor said, his voice heavy with the accent of his native Germany. "I have discovered I am accident prone. Not a very scientific deduction, you see. But it is true."

The discovery seemed to make Dr. Hans Hahn happy. Gnome-like, his small body tensed eagerly behind the desk, his bald dome sparkling in the fluorescent lights, the professor pointed to a large adjustable cane leaning against the wall of his office on the campus of Transylvania College in Lexington, Kentucky. "I must walk carefully," he added. "No more accidents can I afford."

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Dr. Hahn believes he can pick out the accident prone in industry, the home and on the highway. His successes are little short of astounding.

Dr. Hahn has spent most of his life looking for people who are accident prone, and in this area of research the jovial 65-year-old professor has few peers. He estimates that about 25 percent of all people are accident prone. That, he says, makes for a lot of accidents. But he is convinced he can pick out the accident prone—in industry, in the home, on the highway. And his long string of successes is little short of astounding.

He once tested employees of the Kentucky Utilities Co., for instance, and singled out a worker as highly accident prone. Not long after, the man was killed in a power-line accident. Another time, skeptical Kentucky State Police officials brought him 10 motorists, 2 of whom had long records of minor accidents. After testing the motorists, Dr. Hahn correctly identified the two accident-prone drivers. Dr. Hahn's work has stirred interest among insurance companies, railroads, aircraft manufacturers and trade unions, each with special reasons for wanting to identify accident-prone people. How does Dr. Hahn do it? His battery of tests is deceptively simple, yet the results are revealing.

In one simple but dramatic test, Dr. Hahn takes his subjects to a small stage and points to the orchestra pit, where he has strewn pieces of broken glass. "It will be most unpleasant to fall down upon the sharp glass," he warns. Then the subjects are taken back about 16 feet from the edge and blindfolded.

Each subject must then walk toward the edge. One may grope fearfully with the first step. The next, however, may walk boldly to the edge and only be prevented from plunging over by two of Dr. Hahn's student assistants.

What does this reveal? The super-cautious man, explains Dr. Hahn, is the neurotic driver who gropes through traffic and causes others to have accidents. The carefree extrovert who walks boldly to the point of no return is the driver who follows too closely, races trains to crossings, and "has absolutely no margin of safety for himself or others."

The normal, safe driver, explains Dr. Hahn, will usually take three or four sure steps, then refuse to advance nearer the waiting disaster. Most children, he adds, walk fearlessly to the brink, confident that something will save them. They would fall over if not stopped.

"I believe firmly that the margin of safety is a deeply rooted trait that shows accident proneness in the form of carelessness," says the professor. All his tests are devised to pinpoint a subject's margin of

safety, which may be affected by fatigue, strain and boredom. Thus some of the tests involve laboratory reproductions of the stresses a subject may find on the open road.

In one test, subjects are given a button to press whenever a light flashes. Usually even the accident-prone subject responds well at first. But then a bell signal is substituted for the light, and finally the two are mixed with no discernible pattern. Then the danger signals are speeded up. Many people tend to panic, try to outguess these signals, or quit in despair.

Another test

In another deceptively simple test, Dr. Hahn asks his subjects to sit facing a large board on which 100 numbers are scattered at random. The subject is told to point out specific numbers. Only about 1 in 10,000 is able to find all the numbers in the five minutes given for the test, says Dr. Hahn.

The average, safe driver will find between 25 and 50 of the numbers, says the professor, because he is searching out and seeing only the important things, such as the other car approaching from a side road. The accident-prone driver will look at a dozen numbers before he finds the one he wants. This driver, says Dr. Hahn, will focus so strongly on one quest that he misses all other signs. He may see the car come out of the side road, but his interest in that car is so intense he will miss the second car approaching head-on.

In yet another test the subject merely adds long columns of figures for an hour. Some subjects grow irritable with the constant adding. These people, says Dr. Hahn, are the ones who grow tired of analyzing and reacting to constant danger signals in traffic—a blinking light, a hand signal, a whistle, a changing light, a horn. Others do well for most of the hour-long test, then their accuracy and attention explode. These people, Dr. Hahn believes, are the most dangerous of all. At the crucial moment they give up reacting to all danger signals. In this particular test, the normal, safe driver will show gradually declining accuracy and speed.

Dr. Hahn emphasizes the importance of the fatigue factor in his tests. "Everybody wants tests that go fast and don't mean very much. In Europe they appreciate that a test must be long and tedious to discover anything," he notes, adding that Germany's nationalized railroads now use his tests, as does the 1,200,000-member German coal-mine union, to ferret out dangerous employes.

Dr. Hahn first became interested in accident proneness while working for his Ph.D. at the University of Heidelberg. In 1933, along with many other Jews, he fled the rising Adolf Hitler and went to Brussels, where he continued his experiments with the Institute for Special Psychological Research. When the institute received an urgent appeal from the Peruvian government for a psychologist to look into the high

rate of accidents in the Peruvian Air Force, it sent Dr. Hahn. A few months later, he was a major in the Peruvian Air Force and head of anthropological research at the University of San Marcos.

Accident-prone pilots

The regularity with which Peru's pilots were demolishing that nation's dwindling fleet of aircraft provided Dr. Hahn with fertile ground for study. "They had many too many breakdowns and crackdowns," he recalls. An elfin smile spreads across his face. "I wiped out the highly accident-prone pilots," he adds.

But convincing the Peruvian brass of the efficacy of his tests wasn't easy. "I discovered when I introduced my testing system there were four highly accident-prone pilots," says Dr. Hahn. Officials weren't impressed. Then, "they (the pilots) all did me a favor. They all four cracked up and were killed. It was the most kind of scientific co-operation. It convinced the Peruvian people it is possible to determine accident-prone pilots before it is too late."

Dr. Hahn came to Transylvania in 1950 as professor of psychology. When not teaching or researching, he tours the world presenting papers and movies on accident proneness. His professional travels are eased by the fact he speaks five languages. In 1962 he was chairman of the symposium on *Man in Space—The Role of the Psychologist,* jointly sponsored by the International Council of Psychologists and the American Psychological Association. He is one of four men without medical degrees who have been elected fellows of the Academy of Psychosomatic Medicine.

Dr. Hahn's fondest hope now is to interest a foundation in financing increased research into accident proneness. "They have so many millions and it could be used so well," he says. His ultimate goal is to develop some form of therapy for the accident prone. But it won't be easy. "Accident proneness is something you are born with," says Dr. Hahn, "and it may be you can never change this trait."

Absent-minded goldfish

MORE than 500 absent-minded goldfish are giving scientists new evidence about the chemical basis of memory. In brain research at the University of Michigan Mental Health Research Institute, Bernard W. Agranoff and Roger E. Davis have learned that the fish's memory can be disrupted by injections of the antibiotic drug, puromycin. The drug "blocks formation of permanent memory but apparently does not affect initial learning or short-term memory," they report. The researchers used goldfish because they have a relatively simple and primitive brain, and biochemical studies can be performed on large numbers quite easily.

American Cancer Society

Dr. Wendell M. Stanley, Nobel Prize winner and head of the Bio-Chemical Laboratory of the Univ. of California, holds a culture bottle of more than 10,000,000 living cancer cells. Dr. Stanley is an advocate of the theory that viruses cause some cancers.

Coming: a cancer breakthrough

Today, treatment for cancer is agonizingly uncertain. But basic biological research is accumulating facts that may soon provide an answer.

by Harold M. Schmeck, Jr.

EVERY two minutes on the average, someone in the United States dies of cancer. During the two-minute interval, others spend more than $700 in trying to understand what cancer is and what can be done about it.

These, in microcosm, are the dimensions of a disease problem that is expected to kill 295,000 Americans this year and to which the nation's medical and biological research forces are devoting $200 million or more annually in research funds.

The annual death toll has been rising steadily for years. Part of the increase results from population growth and from the increasing number of persons who live to reach the older age brackets. Only heart disease kills more Americans.

The figures on cancer research funds have risen sharply in the last decade, but any specific figure is, at best, only an approximation. It is becoming more difficult to draw a meaningful line between biological research in general and research useful in the study of cancer specifically.

The huge flowering of research aimed at cancer is helping scientists understand the fundamentals of life itself. Research concerned only with life's basic processes, in turn, is making far clearer the nature of cancer. The intermingling of these two great streams of research is certain to have great impact on human health and control over disease. Many specialists believe this effect will disclose itself slowly, with gradually increasing force, over decades. A few would not be surprised to see some dramatic—although as yet unforeseeable—result soon. It is becoming increasingly apparent that the puzzle of cancer is probably very closely related to the puzzle of life itself. Research in biology at the most intimate level—the biology of the very molecules that are the basis of life—has become a most exciting and probably portentous area of cancer research too.

Virology

The study of viruses has become particularly important in cancer research both as a model for studying life in its smallest details and because of accumulating evidence linking viruses with cancer.

"It is clear that the most active field during the last five years or so has been in virology," said Dr. Carl G. Baker, associate director for program of the National Cancer Institute.

Recent discoveries in molecular biology, Dr. Baker indicated, lie close to the heart of the great question: How is cancer caused?

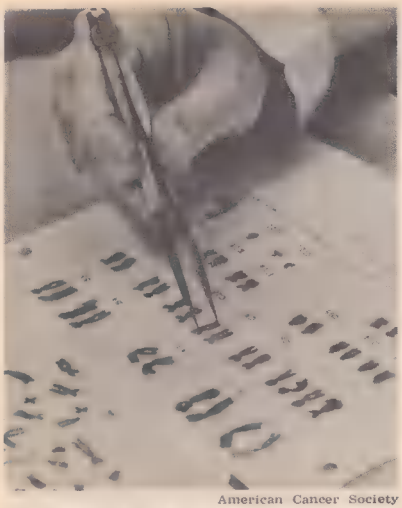
In a sense, there have been accepted answers to this question for a long time. Cancer is a matter of unregulated, undisciplined growth. Cancer can be caused by radiation, by chemicals and, in many species of mammals as well as in birds, reptiles and even plants, it can be caused by viruses.

The question that is the focus of much current research, however, probes much deeper than these answers. The real question is: Specifically, how do these cancer-promoting agents subvert living cells and transform them and their offspring into murderous outlaws?

The task is immense, but many specialists believe immense progress has been made just within the last few years. This is sometimes obscured by the fact that items in this progress do not necessarily bear any label linking them directly with cancer.

One of the reasons for the great interest for cancer research workers in viruses is that these unimaginably small particles are really little packets of nucleic acid wrapped in a protein coat. The nucleic acids DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are the master chemicals of life. The former carries the code of life, the latter is the chief agent in the translation of this code into manufacture of protein.

Viruses contain either DNA or RNA, never both. They are known to be able to introduce their own



American Cancer Society

A "karyotype" (chart matching pairs of chromosomes) gives a profile of the genetic factors that operate within the human cell.

nucleic acid into the cells they infect so that this foreign nucleic acid subverts the cell to abnormal functions. Sometimes this is the production of a new virus and destruction of the cell. Sometimes it is production of abnormal cells.

It has long been assumed that the path of command governing a cell's life goes from the DNA to the RNA and thence to the production of the compounds that make cells and give them the functions of life.

Recently, however, a scientist from the University of Wisconsin has described research that seems to contradict this idea of a one-way path of command. The studies were reported by Dr. Howard J. Temin during one of the major symposiums of the American Association for Cancer Research's annual meeting.

His evidence, stemming from studies done with known cancer viruses of fowl, suggests that perhaps the RNA can sometimes dictate to the DNA.

If further research confirms this idea, some of the important current concepts of biology may be turned topsy-turvy.

"Germ-free" animals

Another item that may contribute to the ferment of cancer research was described in one of the several thousand reports given at the huge annual biologists' meeting —that of the Federation of American Societies for Experimental Biology.

Dr. Morris Pollard of Notre Dame University, a leading specialist in research with "germ-free" animals, reported observing the presence of viruses in those supposedly germ-free mice that develop cancer. This finding may strengthen the hand of those who believe viruses may be involved not just in some, but in all cancers.

Still another item of research, reported in the journal *Science*, implicates free DNA circulating in the blood as a possible explanation of cancer metastases—those secondary cancers that spring up at sites far distant from the original tumor, but nevertheless stem from the original. Drs. Aaron Bendich, Tadeusz Wilczok and Ellen Borenfreund showed that DNA from the mouse cancer virus called polyoma can be transported from one part of

Specialists see the possibility of vaccines, but few express hope that there will soon be any vaccine useful against a wide range of cancers.

the body to another in biologically active form.

The authors said their research suggested the possibility of using antibodies against nucleic acids to prevent metastases.

The importance that some of the old hands at cancer research attribute to studies of viruses and research at the molecular level in general is such that one commented recently:

"If you really want to know what's going on in cancer these days you go to the virology meetings and the biochemistry meetings, not to the cancer meetings."

It is from these fields, many specialists believe, that the great transforming advances will come in man's understanding of cancer as the great puzzle of biology. The scientists's statement, however, did not imply that nothing is being accomplished in that other field—man's war against cancer.

The American Cancer Society estimates that one cancer patient in three is being saved today and that one in every two might be saved if proper treatment was given early enough. Deaths from cancers of some body sites have been declining for years. While the reason for this is unknown in some cases—cancers of the stomach, for example—it is known in others. The toll from cancer of the cervix in women, the classic example, has been reduced markedly over the decades through the impact of efficient measures for early detection.

Often, however, progress against cancer seems painfully slow.

Some specialists believe the conventional mainstays of cancer treatment—surgery and radiation—may be reaching a plateau of usefulness from which further progress will come only in small, painfully won increments, at least until some new factor in strategy or understanding is added.

Earlier detection of cancer might be such a factor, some specialists believe, but only if the term inplies detection in an earlier biological phase of the disease.

Cancer drugs

Chemotherapy—the use of drugs of various kinds to treat cancer—is considered another factor for potential marked improvement. At present, drugs have showed usefulness primarily against disseminated cancers such as the leukemias, but even in this area of their great promise, specialists hesitate to speak of cure.

Nevertheless, it has been estimated that about 100 children diagnosed as having acute lymphocytic leukemia more than five years ago and treated in this country with the

most effective available drugs are still alive and free of major symptoms of the disease. A few have gone substantially longer than that.

Without treatment this cancer of the blood-forming tissues would almost always be fatal within a few months.

90% temporary effectiveness

While most of the 17,000 American children who get the disease yearly still die within two years, the number in whom drugs can evoke some temporary remission is now close to 90 percent, according to one specialist.

The leukemias, however, constitute only a small portion of all cancers of man and, for most types of cancer, the potential promise of drug treatment remains to be fulfilled.

Another possibility for improvement is suggested by Pat McGrady, science editor for the American Cancer Society, in his recent book, "The Savage Cell." Many additional lives might be saved, the author says, if the advanced methods of modern diagnosis and treatment that have proved themselves through experience at great medical centers were far more widely used.

Many specialists, however, are convinced there is need not only for capitalizing on those scientific gains already made, but also for exploiting new approaches to the problem of cancer.

One such area that is receiving increased attention is that of immunology. This is the branch of biological science that deals with the body's natural systems of defense against germs and against other foreign materials that may intrude into the body.

Some specialists are hopeful that immunology can be made useful against cancer. Dr. Chester M. Southan of the Sloan-Kettering Institute for Cancer Research, who has done much research in this area, considers immunological approaches potentially promising for eradicating the last vestiges of cancer from a person in whom most of the malignancy has been removed by surgery or killed by radiation or drug treatment.

Vaccines

Although some specialists discuss the possibilities of vaccines against certain cancers, few express hope that there will soon be any vaccine useful against a broad range of cancers.

For almost any immunologic approach it is necessary to demonstrate that the human cancer does have antigens that the patient's body can recognize as foreign. An antigen is anything that prompts the body's immunological defense system to produce protective antibodies against it. Although every living tissue contains characteristic antigens, an individual does not ordinarily react against his own antigens because they do not appear as foreign.

Until recently the idea that there

may be antigens peculiar to cancers was only a hope of research workers, according to Dr. Lloyd Old, also of Sloan-Kettering, who has specialized in the study of these matters. At present, he said, the point may be considered proved as far as many animal cancers are concerned but still awaits proof for any human cancer.

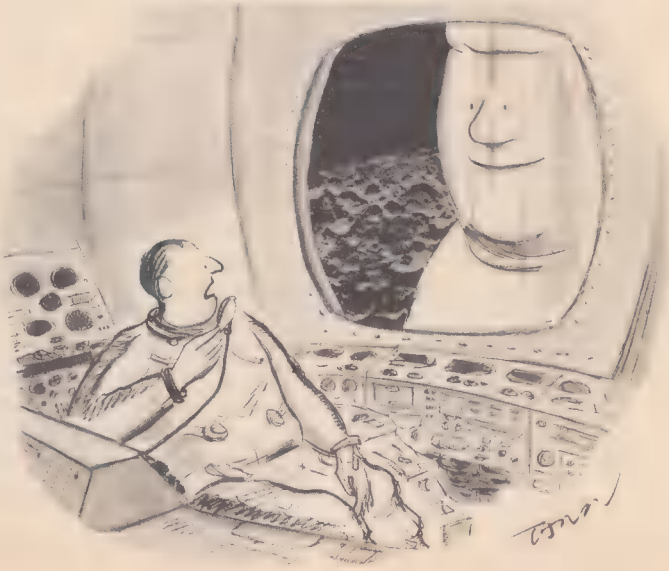
Research that has a bearing on cancer is huge in breadth, depth and scope across the panorama of biological and medical research. To some there seems to be a distressing disparity between the scope of the enterprise and the pace at which major answers are being turned up to help solve the problems of disease, suffering and death that human cancer involves.

Dr. Michael B. Shimkin, professor of medicine at Temple University, Philadelphia, is one among the many leading scientists who take a far more optimistic view.

Knowledge is being accumulated today on a scale and at a pace probably never equalled before in man's history, Dr. Shimkin says. The effects of this may not be apparent immediately, he continues, but the information and insights are accumulating like water behind a dam. At first the water may seem to be accomplishing nothing—until it reaches the spillway level and things begin to happen fast.

There are many scientists who think the water is climbing rapidly toward the spillway in biological research today.

". . . Other than that, he appears to be quite friendly!"



Life in 1990

Remember how we lived in 1940? That was just 25 years ago. What will another 25 years bring? Here is the sprightly, educated guess of one of America's most readable, astute science writers.

by Isaac Asimov

How did I ever get into the predicting business? Predicting the future is a hopeless, thankless task, with ridicule to begin with and, all too often, scorn to end with. Still, since I have been writing science fiction for a quarter of a century, the myth has arisen that I have a private spyglass into the future.

To predict the actual future, I must not suppose. I must take a condition that will *certainly* exist in the future and try to analyze the possible consequences. And to decide on a condition that is certain for the future, it is best to look at the conditions that prevail today.

There are now three billion people on this planet. For the three leading nations of the world, the population figures are now roughly 700 million for China; 250 million for the USSR, and 200 million for the United States.

What will the situation be a generation from now, say in 1990, assuming that we avoid a thermonuclear war? It is virtually certain that the population will have increased by at least 50 percent.

Very well then, let's get down to cases. How will everyday life, here in America, be lived in 1990 in the light of the population explosion? An obvious consequence is an overwhelming appreciation of the necessity of conserving the planet's resources—not out of idealism, but out of sheer self-love.

Air is inexhaustible, for instance, but to be useful it must be clean. The problem of polluted air is al-

Pure air will be so precious, smokers will be restricted to "smokatoriums."

ready serious and, by 1990, it will be unthinkable to dump untreated smoke and exhaust into the atmosphere as it is now unthinkable to dump sewage into a city reservoir.

It is possible that this will impinge on the average human being most directly in the form of bans on smoking in the open air. It will probably be discovered that air pollution (including the tobacco smoke discharged from the lungs of hundred of millions of smokers) contributes to lung and skin cancer even among non-smokers. Smoking may therefore be restricted to "smokatoriums."

By 1990 more and more apartments will be outfitted with devices for circulating filtered air. The old-fashioned phrase "fresh air" will be replaced, perhaps by the phrase "raw air" and this will be considered increasingly unsuitable for delicate lungs, especially in urban areas.

Again, water is inexhaustible but fresh water is not. The squeeze for fresh water is on already. However, it seems quite likely that before the quarter of a century is up there will be practical methods for desalinizing ocean water so that, in principle, fresh water will be inexhaustible. But desalinized ocean water is bound to be considerably more expensive than natural fresh water. It will be too expensive in 1990 for any use other than drinking or cooking. The fight against water pollution will have become strenuous indeed.

I once wrote a story of a society in which fresh water was so scarce that men brought their own pocket flasks of water when they went visiting. They had them filled at municipally run pumps, which charged by the pint. I don't think we'll be anywhere near that point in 25 years, but we're heading in that direction.

Energy sources plentiful

Energy sources will not yet present a serious problem in 1990. With luck, this may be no problem at all. Oil and coal will still be with us and nuclear fission plants will have become common. The great problem of disposing of atomic wastes safely will, in all likelihood, be solved. (My guess is that it will be done by mixing the wastes into glass blocks which can then be dumped into salt mines or the ocean deeps.) There will even, I suspect, be an experimental power plant or two, based on hydrogen fusion, somewhere on the planet, and considerable talk about solar power plants.

Minerals are less easy to be optimistic about. The world need will rise sharply and some mineral supplies are already critically short. Great sources, as yet untapped, are

the bottoms of the continental shelves where, in some cases, nodules of metal compounds lie for the taking. Ocean dredges should be exploiting this resource by 1990.

What will impinge most directly upon the average man, however, will be the pressures on soil and living space. There are no easy solutions to the problem of crowding more and more people into the cities, but I think that by 1990 we will plainly see the direction of forthcoming change. The movement will be no longer upward into skyscrapers as has been true for the last two generations, but downward. This is not necessarily a welcome thought to those used to living in the open, but it may be inevitable and people will come to see advantages in it.

People already work and live in beehives, surrounded at all times by artificial light and conditioned air. They would scarcely know the difference if they were suddenly transported underground. Consider, too, that underground temperature changes are minor so there would be less problem of cooling in the summer or warming in the winter. If a whole city were built underground, then transportation would never be upset by rain or snow. Production would increase in efficiency, since round the clock shifts would be very easy to set up in surroundings in which the difference between day and night is minimized.

Furthermore, the earth's surface will not be directly encumbered by the city. The ground above a large city may be devoted in part to park land for recreation and in part to farming or grazing. However, even in 1990 this kind of plan will still be in the reasonably distant future. Increasing numbers, though, of individual houses and factories will be built underground by then.

Beat the crowd

The population pressure will make the less desirable areas of the earth's surface seem more desirable, particularly for people who wish to get away from crowds. Those who can afford it will retreat into the isolation of the mountains, where the transportation and communication methods of 1990 will keep them in touch with humanity without being physically crowded.

The jungle will have fewer terrors, for the large predators will be either extinct or definitely on the road to extinction by then, and the more deadly insects, worms and micro-organisms will be under better control. Increasing use of nuclear energy will begin to open the Arctic coastlines and even the empty continent of Antarctica to habitation.

Most startling of all, possibly, will be the beginning of a move-

The population explosion will force cities underground and even under water.

ment in the direction of the continental shelves. Many of the advantages of living underground can be duplicated underwater, with the added convenience that those fond of water sports need only step out of doors. The chance of catching dinner in your front yard (once possible for early Americans) will be possible again underwater. Perhaps in 1990 a large hotel will be in the process of construction underwater—off Miami, Florida, I suspect.

Probing space

Population pressure will not yet have driven men off the planet altogether. There ought to be a going colony on the moon, composed of changing shifts of highly trained and specialized personnel, and there will be plans for landing a man on Mars. The average man, nevertheless, will be as far removed from the chance of a trip into space in 1990 as he is now. But the space age will be far advanced just the same. Unmanned planetary probes will by then have explored the entire inner solar system and plans for penetrating as far outward as Jupiter will be under way. Man will take for granted the existence of satellites for use in weather forecasting, communications and navigation.

Despite all this, the major human conglomerations of 1990 will still be in the same large cities we have today; cities which will, by then, be enormously larger. The northeastern seaboard of the United States will be, in effect, a single large city of about 40 million.

To keep the millions of city dwellers comfortable, there will have to be considerable refinements in transportation and communications. Garages will proliferate and become lavish, jutting both above ground and below. Their effectiveness will be accentuated by the growing use of two-seater runabouts for intracity use. (I suspect that excise taxes will rise heavily on over-all car measurements in an effort to encourage the use of extra small compacts.)

Personal vehicles will be separated from commercial vehicles as much as possible. The elevated street will become an increasingly common sight in the congested centers of the huge cities and will be used by the small cars, while buses and trucks will be confined to what is now street level.

Helicopter deliveries of nonbulk items will achieve limited popularity. The newer buildings of 1990 will be topped by small heliports, perhaps as much for show and prestige as for use. There will also be an increasing tendency to make use of tubes and compressed air for mail service. The post office will

There'll be a colony on the moon and we'll be ready to land a man on Mars.

Ground-effect vehicles will move across the country without the need for roads.

be extensively automated. I suspect that large office buildings, at least, will have their mail delivered by puffs of air, with it then being rerouted to individual suites with a minimum of human touch.

Subways, too, will become increasingly automated and there will be a strong trend, by 1990, toward continuous chain subways—a long series of coaches traveling the length of a line and back, circling wide at either end. This will still be confined to small shuttle lines, but engineers will be presenting designs for citywide affairs of this sort, with highly controversial solutions for such matters as getting on and off a continuously moving chain and for methods of interconnecting the separate chains.

Between the cities, the steady decline of the railroad will have produced trucks and buses of unprecedented size and sorts. More and more they will come in tandem and highways will have to take these monster vehicles into account. They will have their special lanes and their special entrances and exits.

Personal helicopters

For other commercial use, 1990 may find the intercity highway passing its peak. The use of personal helicopters will increase but even more so, perhaps, will the ground effect vehicle come into its own. The latter, running on jets of compressed air rather than on wheels, will not require paved highways but will be able to move along dirt roads with equal ease or, for that matter, across open country (if rendered not too uneven by either natural or man-made obstacles) and bodies of water.

Hot-rod hovercraft

The ground effect vehicle will undoubtedly require drastic changes in traffic regulations. One of the growing irritations of 1990 will be the disregard of drivers of such vehicles (particularly teen-agers) for private property rights. I imagine there will be a tendency for irascible landowners to raise deliberate obstacles to discourage this and if a youngster is killed because of such an obstacle, a pretty legal hassle will ensue.

Perhaps the most forceful effect of the population explosion will be in connection with food. The United States will not be experiencing the famines that will be all too common in much of the world, but we will have to grow more food conscious and less food particular. There will be an increasing tendency to grow less specialized in our diet, as well as a tendency to drift away from meat and toward fish and grain.

Items not now considered palat-

Kitchens will be automated and come to resemble the cockpit of a jet bomber.

able will be entering the diet, though only on an experimental basis (for it takes the threat of actual starvation to make a population give up its food prejudices—and sometimes not even that). Seaweed is one example of a food which may reach the restaurants. There will also be increasing experimentation with cultured algae and yeast. The supermarkets will be stocked with such items artificially flavored to resemble meat, liver, cheese, etc. I daresay that in 1990 their taste properties will still leave something to be desired.

Gadget-centered

Only one major item other than the population explosion seems almost certain to come to pass—the continued push toward an extreme of mechanization and automation. This will be particularly true in the United States which, of course, will continue to live its gadget-centered existence.

This will affect the housewife, from shopping through final consumption. The supermarket of 1990 will have its items coded. The shopper will mark off the code numbers of desired items on appropriate cards, using shielded display counters as a guide. Her order, properly packed, itemized and charged, will be waiting for her within minutes.

Most food items will be prepared for cooking in kitchen units that will do the job with a minimum of human interference. The kitchen may come to resemble the cockpit of a jet bomber. In fact, there will be apartment houses in 1990 that may very well offer a community kitchen for the use of their tenants (as they now offer community laundries), since that will eliminate the wastefulness of elaborate units for each apartment. (Even so, kitchenettes for preparation of breakfasts and snacks would remain in each apartment.) The trend would definitely be for "restaurant eating," even at home.

The "servant problem" will continue insoluble in the United States and the substitution of the household robot will not alleviate the situation. What will alleviate it will be the increasing tendency to reduce the chores for servants. The increasing use of filtered air will make the dust problem smaller. Washing by ultrasonic vibrations in addition to (or in place of) soap may make that task much quicker and easier.

Automation will bring about a change in work outside the home. More and more, the sheer use of muscle or the routine use of brain will vanish. There always will be creative occupations, of course, as well as a need for executives, administrators and for all people who

must deal with other people. There will also be a tremendous increase in the number of people who must, in one way or another, deal with computers and their offshoots.

More science

For that reason, education will feature mathematics and science more and more. Such items as binary arithmetic and computer languages will be taught from the earliest grades. Personalized education and detailed teacher-student contact will tend to restrict itself to two classes of children—the retarded and the very bright.

The greatest single problem introduced by automation will be surplus time. The large majority will be working only 30 hours a week at most, and will therefore be more subject than ever to the dangerous disease of boredom. There will have to be a great emphasis on recreation and entertainment, and never in the history of man will so great an importance be attached to the general profession of "people amusing."

The television set will be, more than ever, the center of the home, and the telephone itself will become almost an item of entertainment. The 1990 phone will be routinely equipped with a television attachment so that one can see as well as hear the person at the other end. The housewife can then enjoy herself twice as much, provided she is in a condition to be seen and is willing to use the vision attachment. (A whole new dimension of strain among friends will arise when one is highly polished and lacquered and wishes to see and be seen, while the other is hung over and wishes to do neither.)

Such a telephone may also revolutionize library work. By 1990 the large libraries will have all but current and popular books on microfilm. All schools and many homes will have microfilm viewers. The large libraries may well be organized to allow telephonic viewing of their microfilms. It will then be possible to check references and obtain information without leaving home or office.

Business by phone

The businessman may view documents and receive reports by "visi-phone." There may even be occasions when conferences by split screen telephone can be arranged. The money expended can be saved on the travel that will not be necessary (except for the large percentage of cases where the travel is an excuse for a junket at the general expense of society).

Sports also will be stressed in the world of 1990, as a good and harmless time consumer. I suspect that

With videophone, we won't just call a person up, we'll also "look him up."

There'll be so many people, some areas may make parenthood vaguely antisocial.

the greatest sports novelty will be flying. Small motors, mounted on the back, will lift a man clear off the ground. This will be a thrill in the first place (who has not dreamed of flying?) and will make room for sport, too. (Will some child living today be the man who will organize the first game of "air polo," using a helium inflated sphere of thin but tough plastic as a ball?)

It may even be that, by 1990, individual flying will have progressed to the point where it will be practical enough and cheap enough for a few to make use of this method for short trips. The junior executive can avoid several miles of bumper to bumper travel by soaring above the cars all the way—and achieve status beside. Watch out for engine failures, however. Local city ordnances may confine him to sidewalks to avoid having him tumble in front of a car.

The changes that will be taking place between now and 1990 will convince people that the trend cannot be allowed to continue blindly, but must be deliberately channeled. There are many today who are convinced that effective birth control of some sort is essential if civilization is to be saved. They are in the minority now—but they won't be.

By 1990, in fact, governmentally organized measures for birth control will be taken for granted over almost all the world. The advance in birth control effectiveness will not be in time to prevent the 60 percent increase in world population by 1990, but it will have reached the point where the percentage of individuals under 21 will be markedly smaller than it is today.

Social attitude

This should bring about a change in the social attitude toward children and family, though this change might not be uniform everywhere. In some areas and among some segments of society, the relatively small number of children may increase the value of those who do exist, thus making that society more child-centered. In other areas and segments, the recognition of the population explosion as the prime danger to man may make children unpopular and parenthood seem vaguely antisocial. In this situation family bonds may tend to dissolve and marriage may lose ground to other less formal types of personal union.

And if 1990 further sees the beginning of a population equilibrium or even a population rollback, the writer of that day forecasting the world of 2090 may be able to be more optimistic about the future than I have been.

How chance affects your life

Phone calls, traffic deaths, courtroom trials, weather forecasts and flu epidemics are a few of the everyday activities controlled by chance.

by Gordon S. Fay

TIME and chance come to all men, warns the Old Testament. For most people these days, the word "chance" immediately conjures up somewhat secular pictures of places like Monte Carlo and Las Vegas, but the statement by the unknown author of Ecclesiastes was prophetic.

Today, probability—the science of chance—plays an amazing role in an enormous number of activities, to cite a diverse few: national defense; the quality of the things you buy; talking on the telephone; hunting and fishing; landing men on the moon; the national toll of traffic deaths on holiday weekends; courtroom trials; weather forecasts; and even the chances of your being exposed to a flu epidemic this coming winter.

Take national defense: in case of war, how confident are we that our missiles and bombers will hit their assigned targets in enemy territory?

Suppose that a certain missile, as it leaves its silo, is calculated to have a one in two (½) chance of hitting its target. This is the overall probability of success remaining after various probabilities, such as those of malfunctions and of being destroyed in the air by the enemy, have been weighed. The probability of a certain something happening is the chance that it will happen, and one chance in two is a case of really taking a chance, so why not send two of these missiles?

Although two missiles increase the probability of success, they don't make it anywhere near a sure thing. According to probability theory, the probability that at least

It might appear that probability was born of necessity in the nuclear age, but actually it had its beginnings over 300 years ago.

one of these missiles will hit the target is 75 percent. (The mathematics: ½ + ½ — ½ x ½ = ¾, or 75 percent.) For an approximate 90 percent probability of success, four such missiles would be launched, which explains why our supply of missiles and nuclear bombs, etc., far exceeds the number of probable targets.

Probability also plays an important part in the Navy's amazing Real World Problem Generator, recently developed by Sylvania Electronic Systems. The generator is essentially a computer which simulates, by mathematical expressions and equations, actual tactical situations (including the electronic "environments") which would be met by our anti-submarine warfare (ASW) aircraft when hunting enemy submarines.

In a laboratory, two opponents—one a "pilot" in an ASW aircraft mockup complete with electronic detection gear, and the other the "commander" of a simulated submarine—tell the computer but not each other what attack and defense actions they take.

The computer scrutinizes each action by probability methods and swiftly gives the opponent the same interpretation of the action that his detection gear would probably have given him. The recipient of the information can then use it to determine his next move, and so on, until the "submarine" is either pinpointed for destruction or gets away. In this manner the Navy can test its electronic detection gear—present and projected—to an extent and efficiency undreamed of only a few years ago.

Military necessity

It might appear from the above that probability was born of military necessity in the nuclear age. Actually it had its beginnings over 300 years ago, in 1654, when an inquisitive gambler in France, the Chevalier de Méré, sent a letter to Blaise Pascal, an acquaintance and a mathematician.

In the letter, the Chevalier asked Pascal to solve two gambling problems: if a certain card game had to be cut short, how should the stakes be divided; and what were the chances of getting two sixes—in modern parlance, "boxcars"—in twenty four rolls of two dice? Despite Pascal's taking a dim view of gambling, and an even gloomier view of the Chevalier's ability to understand any mathematics at all, Pascal couldn't help becoming interested. Thus began the formal study of probability.

Probability has come a long way since then, one of the most astonishing discoveries being that many

seemingly haphazardous events in our lives actually follow some pattern of probability. Thus the probability of their expected occurrences can often be predicted. Take your telephone, for example, one of 90 million in the country.

Three hundred and fifty million calls are made daily in the United States, and every time you pick up your telephone you become a player in a mammoth game of scientific chance. The numbers of telephone calls coming into a central office or switchboard follow a probability pattern called the "Poisson distribution." Using this and other probability, telephone engineers can predict the expected number of calls during given periods of time, the expected durations of the calls, the chances of busy signals, and in this way design and operate the complex equipment with a high degree of efficiency.

This "telephone call" pattern is woven into our everyday living and into our very bodies. Your blood count, as determined in a laboratory, is governed by the Poisson distribution; the National Safety Council uses the Poisson pattern to forecast the expected number of probable deaths on holiday weekends, once the toll has reached an expected number; the check-out lines in supermarkets follow the pattern, and marketing experts use Poisson probability to establish the number of check-stands needed, their locations, etc.

Perhaps the classic no-nonsense validation of any mathematical truth occurred in the late 1800's, when a ten year study by a German mathematician demonstrated that the number of Prussian troopers in a corps kicked to death by horses followed the Poisson distribution.

"Watchdogs"

A major current use of probability occurs in the fields of reliability engineering and quality control, the "watchdogs" of practically everything we buy. Reliability is the probability that a given something will perform its mission satisfactorily over a given period of time, and thus probability has a lot to do with everything from the smallest transistor in a pocket radio to the largest and most involved parts and assemblies in industrial, military and space "hardware."

Quality control would be impossible without probability and its helpmate, statistics. In mass production, the key word in both reliability engineering and quality control is "sampling."

Imagine a batch of mass-produced items which are being turned out. How do you determine that each light bulb, bearing, bushing, bullet, or what have you, is probably satisfactory?

The surest way to find out would be to burn each bulb for the minimum specified number of hours; subject each bearing and bushing to many hours of actual operation; and fire each bullet after carefully inspecting it. Such procedures would, of course, leave the manu-

Probability theory is being employed by lawyers in courtroom trials, which are in themselves outstanding examples of probability application.

facturer long on knowledge but short on anything to sell.

So, random samples of a product are taken and these samples, representing the entire batch, are tested and inspected. Probability calculations then determine whether any deviations are chance occurrences, or whether part or all of the batch is "out of control."

Buyers as well as manufacturers use random sampling to determine whether or not a particular batch of some manufactured product will be accepted. The United States Department of Defense, for example, uses random sampling, before accepting supplies from contracting manufacturers.

Probability and sampling are hurtling into space. As an example, consider a little-known but extremely important role of probability in the Apollo program, our project to land men on the moon by 1970. In addition to the fact that the reliability of every part of the vehicles must be of the highest order, what about the "quality" and the "reliability" of the landing surface?

No matter how many moon photographs are taken, no matter how many Surveyors do or do not send back information concerning their particular landing spots, no matter how many arguments erupt concerning the constitution of the moon's surface, the fact is that none of these activities, singly or together, will answer the big question. That is, "What is the composition of the rock in and under the 30 or so square feet upon which the curved "feet" of the Apollo lunar excursion module will come to rest?"

Lunar landing

This will never be known for sure until the landing is made. All we can really say, until then, is "probably," and probability will therefore be a major factor in picking out the safest landing spots. Right now, Bellcom, a Bell Telephone System company, is carrying on statistical studies of the probability of safe lunar landing sites in terms of probable moon surfaces.

Other "outdoor" uses of probability occur closer to home. Every year, state and federal conservation experts sample the animal populations, and on the basis of total populations estimated by probability, decide the lengths of hunting and fishing seasons, and the daily and seasonal limit. As an example of the care required, a spokesman for the U. S. Department of the Interior said in a critical decision involving an important game source, the probability of making an incorrect estimate of animal

population must be reduced to about one year in twenty.

Probability, along with conservation, has also gone to sea. International fisheries commissions use sampling of catches, plus analysis of size by probability, to decide possible changes in fishing locations or amount of catch. The Inter-American Tropical Tuna Commission maintains a close watch on the supply and size of tuna in this way.

The United States Weather Bureau is currently carrying on research involving probability and computer programs in forecasting hurricanes and their paths. Forecasts such as "60 percent probability of rain today" are already familiar to residents of cities such as Seattle, San Francisco, Los Angeles, Hartford and New York.

Various uses

It would be difficult to name any important activity which does not rely heavily upon probability. It affords food researchers a means by which to make our foods more palatable, safe and cheaper. Even traffic is being analyzed by probability. Chicago, Pittsburgh and Philadelphia traffic engineers have already used probability to analyze traffic flow, and similar studies are now being made in Australia, England, Germany and Scandinavia. The National Security Agency of the Department of Defense uses probability and statistics for designing cryptographic systems and procedures. Some experts claim that stock market prices follow a probability pattern known as "the drunkard's walk," an observation that some people would heartily subscribe to, without even knowing what the mathematical features are. Incidentally, it was the "drunkard's walk" which solved the random motions of neutrons, the necessary step before the harnessing of nuclear energy.

More and more, probability theory is being used in law, as lawyers in increasing numbers depend on it in courtroom trials which are in themselves outstanding examples of probability application. Recently, for example, in Long Beach Superior Court, in California, a young prosecuting attorney used probability to show that the probability that an accused pair, on trial for robbery, had committed the crime was about 12 million to one. Conversely, two weeks later, in Los Angeles, in a different trial, a defense attorney showed by probability theory that any one of six people could have committed the store theft of which his particular client was accused, thus getting the case dismissed.

Probability theory and statistics go hand in hand, in the application of an important probability distribution called the "normal curve," a bell-shaped curve which is used to analyze a multitude of data, from lengths of tobacco leaves and tuna fish, through the most probable values of measured lengths of an object, to I.Q. scores and college and school grades.

By the third week of an outbreak of influenza, probability theory applied to statistics can pretty well tell if an epidemic is in progress.

The use of probability and statistics in determining insurance rates is well known, but there is another application of the probability-statistics duo which is also of great interest to all of us.

This refers to the field of epidemiology, the study of epidemics. A lot of people are already asking this question: "Will the United States suffer a major epidemic of Asian influenza this coming winter?"

Now, probability theory, applied to statistics, can pretty well tell, within the third week of an outbreak of flu, if a true epidemic is in progress, but can it forecast an epidemic before it comes upon us?

No, it can't. Probability does not predict, in the crystal ball sense, but look at these statistics, and meet "empirical probability": the United States suffered its worst outbreaks of Asian flu, of epidemic proportions, in the winter of 1957-58; in the early months of 1960, and in the early months of 1963.

Statistics also indicate that this type of influenza is cyclical in spans of two or three years, but not longer than three. Before this winter, then, we should start thinking about getting flu shots in time—in all probability.

Take a chance

The questions below illustrate some interesting fundamentals of probability theory. The answers are given on the next page.

1. When a coin is tossed once, the probability of "heads" is one in two (½), just as it is for "tails."
   Suppose that a coin is tossed three times and that "heads" comes up each time. Is the probability now greater than ½ that "tails" will occur on the fourth toss?

2. Suppose that you are at a meeting of forty people, or work in a department of forty people, or are in a bus with forty people, etc.
   Which of these is the probability that two in the group have the same birthday (month and day)? 9/10; 1/20.

3. George Smith was looking at a table of populations of towns in his state. He told a friend that the first digit of each population figure

was more often 1, 2, or 3 than it was 7, 8, or 9. His friend said, "Maybe, but it's not true for most statistics." George, however, claimed that he had stumbled upon a scientific truth and that the first digits in most statistical tables were more liable to be small digits than large digits.

4. An acquaintance tells you, "I have two children. One of them is a boy." What is the probability that the other child is a boy—1/2 or 1/3?

5. Suppose that the acquaintance, above, had told you, "I have two children. The *older* child is a boy." Now what is the probability that the other child is a boy—1/2 or 1/3?

Answers

1. No. The coin doesn't know what is going on, so the probability of "tails" is still 1/2.

2. 9/10. For a group as small as 25, the probability of two people having the same birthday is still greater than 1/2. For any number over 50, it's practically a sure thing.

3. George is right. This strange fact was discovered only within recent years—most first digits in tables are small digits. Try it out with population tables, tables of heights above sea level, tables of distances between cities, daily attendances at the World's Fair over a one month period, etc. You will find that the first digit of each number is more often a small digit (1,2,3) than large (7,8,9).

4. 1/3, and don't feel too badly if you missed it. Most people do. The possible orders of birth are important here and there are three possible combinations: (1) older boy, younger boy; (2) older boy, younger girl; (3) older girl, younger boy. There are *three* possibilities, but only one (Number 1) is the possibility that the other child is a boy, also. So, one out of three, or 1/3.

5. 1/2. Check the possible combinations and you will see that (3) is impossible. This leaves *two* possible combinations of which one (Number 1) is the possibility that the other child is a boy, and the probability of that occurrence is thus 1/2.

Chemist Robert J. Herschler accidentally discovered remarkable properties of DMSO.

Report on DMSO

A colorless, odorless laboratory curiosity has become the "hottest" item in modern drug research. Here is what it can and can not do.

by Andrew Hamilton

DIMETHYL sulphoxide — better known as DMSO—is a clear, colorless liquid that is practically odorless in its pure state. If you saw it in a glass, you'd think it was water. Until two years ago, this harmless-looking stuff was something of a laboratory curiosity. Today it is the center of a rousing medical argument.

Many doctors hail it as a spectacular new "wonder drug" whose ability to relieve certain kinds of human pain and suffering is unsurpassed.

Others denounce it as a "cruel hoax" and doubt seriously that its expected miracles will ever materialize.

Basically, DMSO is a solvent, chemically related to acetone. It was first synthesized by German scientists in 1867. In the early 1950's, the Crown Zellerbach Cor-

poration, second largest paper manufacturer in the United States, discovered that DMSO could be produced from lignin and built a conversion plant.

For several years, Crown Zellerbach sold DMSO as a commercial solvent for a dozen or more manufacturing processess—including the producing of synthetic fibers. Its medical possibilities were discovered only through a series of random experiments and bizarre accidents.

Five years ago, Robert J. Herschler, a young Crown Zellerbach chemist at the company's paper products laboratory in Camas, Washington, began to test DMSO for its solvency. Among other experiments, he tried dissolving pesticides in DMSO, coloring the mixture with dye, then injecting it into trees. With miraculous speed, the colored liquid spread through trunk, branches, leaves and fruit. Later experiments showed that DMSO protected plants from mildew, blight, scabs and cankers.

During such research, Herschler and an assistant learned to respect DMSO's penetrating power. "We were working on a poisonous insecticide that normally shouldn't have gone through either our rubber gloves or our skin," he said. "But the highly solvent DMSO spread the poison through us like it did through the trees. We were sick for awhile."

Dr. Stanley W. Jacob, a young University of Oregon Medical School surgeon, began to work with Herschler on animal burns. When DMSO was painted on burned rats, they recovered rapidly. One night, however, while working alone on a type of mustard gas, Herschler spilled some on his forehead and arms. He called Dr. Jacob.

"Now we can see what DMSO can do for *human* burns," he said—almost happily.

It works

Herschler painted his left arm with DMSO, but not the right. In a few minutes, the burned left arm felt better. In 30 minutes the pain was gone, and the next day the burns had started to heal. The right arm and forehead continued to be red and raw.

In December, 1963, the University of Oregon Medical School announced preliminary results of experimental work with DMSO. The announcement fired the imagination and hope not only of doctors, chemists and drug manufacturers, but of farmers, zoo directors, fruit growers and race horse owners.

But a negative reaction soon set in. "Sounds like the old snake oil pitch to me," said one doctor. "I've seen wonder drugs come and go," said another. "The jury is still out on this one."

Last April the *Journal of the American Medical Association* urged a go-slow policy and deplored the excessive publicity given DMSO in the past few months. In the same issue, however, the AMA

Research indicates that DMSO can kill pain, speed wound-healing, banish headaches, relax muscles, purge poisons and reduce blisters.

Journal published "with reluctance" an account of 548 patients treated with DMSO for musculoskeletal disorders. The paper was written by Dr. Jacob, Herschler and Dr. Edward E. Rosenbaum, also at the University of Oregon.

Where do we stand at present with regard to DMSO? Is it truly a wonder drug? In what ways is it likely to be most effective? When will it be available to the public?

At the present time, DMSO is one of the most intensively researched drugs in the world. An estimated 2,000 doctors are conducting rigidly-controlled experiments on DMSO to (1) determine its effectiveness, (2) to make certain it is absolutely safe and (3) to determine any side effects. The tragedy of thalidomide will long be remembered.

So far, medical research at the University of Oregon and elsewhere indicates that DMSO kills pain, speeds wound healing, banishes some headaches, reduces blisters, relieves certain respiratory allergies, relaxes muscles, purges poisons from the body and alleviates the pain of several kinds of bursitis.

The April issue of the AMA *Journal* indicated that of 548 cases of musculoskeletal disorders studies by Jacob, Herschler and Rosenbaum, 437 "were considered as unequivocally improved," and that "no serious clinical toxicity has been encountered to date."

Some examples:

- A 14-year-old boy had been struck on the right cheek in a fist fight. The cheek was cut, and swelling extended to the bridge of the nose and the eye. An hour after the application of DMSO, irritation, pain and swelling had disappeared.
- A 52-year-old college professor suffered from subacromial bursitis which still pained him after treatment with cortisone, surgical removal of calcium deposits and drugs. When treated twice a day with DMSO, he could stop taking pain-killing drugs in 48 hours, and all traces of the bursitis were gone in three months.
- Several patients with gout had their puffy, red, painful feet painted with DMSO. The pain stopped in 30 minutes. Most were walking the next day.

Dr. Arthur L. Scherbel and associates at the Cleveland Clinic found that DMSO was helpful in reducing multiple ulcers of the fingertips and scleroderma, the discoloration and hardening of patches of skin. In some patients, healing began in a few days.

Because it is such an effective solvent, DMSO is able to transport other drugs into the body through the skin—rather than by injection or by mouth. In fact, a person

treated with DMSO can taste the drug in a matter of seconds. Some say it resembles the taste of oysters, others liken it to garlic.

DMSO is also being tested widely by veterinarians in the treatment of animal diseases and muscular ailments. It has alleviated pain, strain and sore muscles in Florida race horses. It has been found useful in treating "hind quarters paralysis" that sometimes affects young tigers in zoos.

Agricultural experiments

Further experiments are being carried out with DMSO in agriculture. It permeates plants not only with pesticides, but with growth promoters and nutrients—throughout leaves, stem and roots. It has aided the growth of strawberry plants, treated viral and bacterial infections in pear trees, prevented the rotting of potatoes in the ground, and enhanced the yield of medicinally-important plants.

Industrially, DMSO is continuing to be used as a solvent in the production of synthetic textiles such as rayon, polyurethane and acrylic. Consequently, these fibers are readily destroyed by DMSO.

What is the real secret of DMSO's magic?

Even those who have worked most closely with it don't have a definitive answer. It appears to have some effect on the permeability of plant and animal membranes, and it seems to block nerve impulses. Put a drop on the skin of the forearm and another drop on a glass slide. The drop on the skin is completely absorbed in 15 to 30 minutes, while that on the glass remains.

"Most of the indications of DMSO's medical uses were based on personal observation of researchers who first used it on themselves," says Herschler. "If DMSO had been screened by standard drug evaluation procedures using laboratory animals, its therapeutic benefits would undoubtedly never have been discovered."

DMSO is made from lignin, also something of a mystery substance that cements the cellulose fibers of wood together. One 35-pound log will produce enough lignin for about four ounces of DMSO. Until Crown Zellerbach learned how to synthesize DMSO, Kraft process lignin was almost worthless. Now the 15,000,000 tons a year that are produced in paper products manufacturing may take on a new value.

Here's where we are today, five years after Herschler began injecting DMSO into trees:

1. The Crown Zellerbach Corporation has a patent on the manufacturing process that produces DMSO from lignin.

2. Crown Zellerbach and several drug companies hold an investigational permit from the U.S. Food and Drug Administration for limited clinical testing with DMSO.

3. Six drug companies have been licensed by Crown Zellerbach to test and develop formulations of the compound for medicinal purposes.

They are: E.R. Squibb Sons; Schering Corporation (U.S.); Syntex Laboratories, Inc.; Merck, Sharpe and Dohme; Geigy Pharmaceuticals and the American Home Products Corporation.

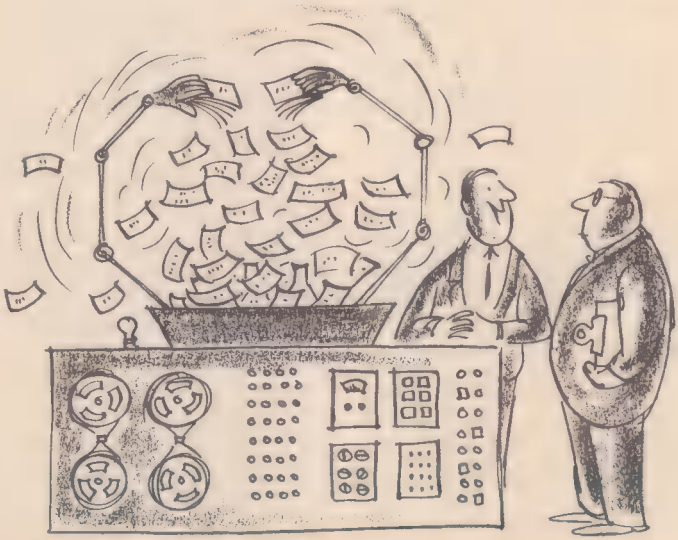
4. DMSO is still an experimental drug in the investigational stage and will not be available to you or your family physician until it has been certified by the FDA. This may be as much as a year or two away.

5. Even when it is available, DMSO will not be the cure-all some people expect it to be. It may relieve the pain of certain kinds of arthritic diseases, but not others. Against cancer it apparently has little effect. Its major role may be as an adjunct to other medicines, and doctors will use it selectively, as they now do other useful drugs.

In spite of negative reactions on the part of some doctors, there is a strong feeling by many others that DMSO may turn out to be one of the world's most useful drugs. Its experimental record to date, its low toxicity and lack of side effects, and its wide versatility all point in this direction.

A majority of scientists and informed laymen seem to think that the jury will bring in a favorable verdict on DMSO and elevate it to the same honored status as aspirin, insulin and penicillin.

"This is the part I like. The random sample phase."



KFS

Bird quiz

by John and Molly Daugherty

THE male Emperor Penguin is a big bird—3 feet in height and 80 pounds in weight—with a big sense of responsibility. The female lays the egg, but the parents-to-be share the care, gingerly transferring their egg (or eggs) from the feet of one to the feet of the other until it hatches.

What else do you know about birds?

1. Although most birds build their own nests or take over that of another, some practice communal building. Which one of these is the "condominium builder?
   a. Red-fronted Thornbills of South America
   b. Woodpeckers of the United States
   c. Oven-birds of South America
2. A male songbird with mating in mind stakes a claim to an area and starts to sing. He's trying to attract a female and warning other males to stay away. If no lady bird shows up within a few days, the bird:
   a. Gives up and shuts up
   b. Sings till the season's over
   c. Flies fast to a new spot where his chances are better
3. Many censuses of bird population have been taken. Which of these birds is most numerous in the Great Plains region
   a. Robin
   b. Horned Lark
   c. Red-eyed Vireo
4. Island birds are often different from mainland birds. Darwin found a bird that wasn't a woodpecker behaving as a woodpecker on the Galapagos Islands. Which one of these was it?
   a. Robin
   b. Sparrow
   c. Finch

5. Small birds have crossed the Atlantic Ocean:
   a. From Europe to America
   b. From America to Europe
   c. Never
6. The heart of a sparrow compared with that of a man is proportionately:
   a. One-tenth as large
   b. About the same
   c. Four times larger
7. About half of the birds are perchers. Why don't they fall off a branch when they go to sleep?
   a. They have a locking mechanism associated with the middle and hind toes.
   b. They sway from side to side almost imperceptibly to maintain a balance even while they sleep.
   c. Their light-weight bones and feathers give them enough buoyancy to overcome gravity.
8. A robin's potential life span is:
   a. 10-12 years
   b. 1-5 years
   c. 15-20 years
9. Such birds as owls, hawks and herons that hunt their prey have:
   a. The ability to focus both eyes in front as people do
   b. Five toes on each foot
   c. A highly-developed sense of smell
10. Which one of these birds takes over the nest of another bird by making a nuisance of itself in an unusual way?
   a. House Martin
   b. Kingfisher
   c. Masked Tityre

Answers:

1—a Red-fronted Thornbills, sometimes called Firewood-gatherers, of South America. Flocks of these birds use sticks to build an apartment-like structure as high as ten feet. It has many entrances to separate flats or nests.

There are other birds that practice communal building.

2—b Sings in vain till the season's over. Bird nature being what it is, some female usually likes his singing and shows up in a few days, but the male *could* miss out—living by instinct instead of insight.

Fine feathers may or may not make fine birds, but the grebe that puts his best ruff forward usually gets the female he wants. So plumage counts, too, in courtship.

3—b Horned Lark. It outnumbers all others in the Great Plains. Many are also found in the plains of Europe and Asia.

The Red-eyed Vireos are more numerous than robins in the Eastern states, in spite of the fact that you *see* more robins. Robins, easily spotted in urban areas, are rather scarce in the wooded areas where great numbers of Red-eyed Vireos are found.

4—c Woodpecker Finch. This finch, one of several varieties on the Islands, is a tree climber. It excavates a hole in soft wood, then holds a tool such as a twig or spine of cactus in its beak to dig for insects in the wood. Of course the Woodpecker Finch hasn't a long tongue like the woodpecker's with which to explore the hole.

5—b Even small American birds get to Europe sometimes, though no small European ones come over here. Strong west winds may make the flight easier from America to Europe than from Europe to America. Given a brisk 30-mph wind, small birds fly 60 to 70 mph. They can fly as high as 20,000 feet.

6—c Four times larger. A bird's heart, as well as its brain, is large for the bird's size.

7—a A locking mechanism. When a bird lands on a perch, it bends its leg, which pulls a tendon behind the leg and toe-bones of the middle toe. This action wraps the middle toe (and hind toe, too) around the perch. Knobs on the tendon engage ridges on the inside of the sheaths covering the bones to lock the foot firmly in position. A notched joint connecting the toe to the leg helps prevent side-slip of the locked foot.

8—a Ten to twelve years. The robin's *actual* life span is far shorter than his potential one. Recovery of ringed birds that have died reveals that if they survive the first winter, they usually live about one year more.

9—a Birds such as owls, hawks, and herons that hunt prey can focus their eyes in front as we do. Birds that are hunted have an eye on opposite sides of their head which lets them scan as much territory as possible. Birds have either two or four toes on each foot, not five. Sight is a much more highly-developed sense in birds than is smell.

10—c The Masked Tityre in South America. When the tityre finds a suitable nest which the South American Woodpecker has built, it waits until the owner is away. Then the tityre fills the woodpecker's nest with rubbish. The woodpecker cleans out the trash, but the tityre keeps refilling it with rubbish until the woodpecker tires of housecleaning and abandons the nest to the Masked Tityre.

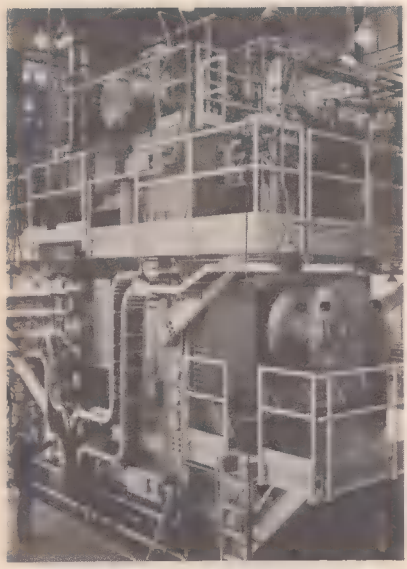
Score Yourself:

9—10 right—A top-flight score.
4— 8 right—Not too birdy.
0— 3 right—Almost a goose egg.

PLEASE EXPLAIN

This new regular feature of *Science Digest* will attempt to answer questions about the how's and why's of science. Send your question to Please Explain, Science Digest, 1775 Broadway, New York, New York, 10019.

What is a bubble chamber?



The 80-inch bubble chamber assembly at Brookhaven Laboratory is world's largest.

What exactly is a bubble chamber? How does it work? What does it look like?

A bubble chamber is a device for the detection of subatomic particles. It was invented in 1952 by the American physicist Donald Arthur Glaser, who received the 1960 Nobel Prize in physics as a result.

Essentially, it is a container of liquid at a temperature above its boiling point. The liquid is under pressure so that it is kept from actually boiling. If the pressure is lowered, however, the liquid can boil and bubbles of vapor appear in it.

Suppose that a subatomic particle, such as a proton or a meson, plunges through the liquid in such a bubble chamber. It collides with atoms and molecules in the liquid, and transfers some of its energy to them. There is then a line of atoms and molecules in the liquid that is somewhat hotter than those elsewhere. If the pressure on the liquid is released, the bubbles of vapor form first along the line of energy left in the wake of the subatomic particle. There is thus a visible trail of bubbles marking the passage of the particles, and this is easily photographed.

This visible trail tells physicists a great deal, particularly if the bubble chamber is placed between the poles of a powerful magnet. Those particles capable of leaving a trail of bubbles always carry an electric charge, either positive or

negative. If they carry a positive charge, their path curves in one direction under the influence of the magnet; if they carry a negative charge, their path curves in the other. From the sharpness or shallowness of the curve, the physicist can determine the speed of travel. From that, from the thickness of the trail, and so on, he can determine its mass.

When a particle breaks down to two or more particles, the trail branches. In case of collision, there are also branches. In a particular bubble chamber picture, there will be numerous trails, meeting, separating, branching off. Sometimes there is a gap between portions of the trail-pattern, and that gap must be filled by some uncharged particle, for uncharged particles, in their travels through the bubble chamber, do not leave tracks.

To the nuclear physicist, the complicated combination of tracks is as meaningful as animal tracks in the snow are to an experienced hunter. From the nature of the tracks, the physicist can identify the particles involved or tell if he has come across a new kind of particle altogether.

Glaser's original bubble chamber was only a few inches in diameter, but now monster chambers six feet in diameter and containing 150 gallons of liquid are built.

The liquids used in bubble chambers may be of various kinds. Some contain liquefied noble gases, such as xenon or helium. Others contain liquefied organic gases.

The most useful liquid for bubble chambers, however, is liquid hydrogen. Hydrogen is made up of the simplest atoms known. Each hydrogen atom consists of a nucleus made up of a single proton, circling which is a single electron. Liquid hydrogen is therefore made up of isolated protons and electrons only. All other liquids have atomic nuclei that are conglomerations of several protons, and of several neutrons as well.

The subatomic events that go on within liquid hydrogen are therefore particularly simple, and are all the easier to read from the bubble tracks.—*Isaac Asimov*

Do we hear sounds in the ear or in the brain?

The brain turns nerve impulses from the ear into the sensation of sound, but research for the space program has revealed that the ear plays a bigger role than was thought. In order to communicate with astronauts over vast distances with little radio power, we will have to send voice messages in the simplest form possible. One way to do this is by breaking spoken sound into its constituent parts, radioing only those parts absolutely necessary to understanding; at the receiving end, they would be part together again to reconstitute speech.

Researchers studied the ear to learn which parts of speech could be dropped. They knew the sensing organ of the ear is the cochlea, a liquid-filled, spiral tube. A vibrat-

ing diaphragm is at the outer, wider end. The tube narrows as it winds toward the inner, apical end. Each nerve cell in the series lined up along the length of the tube is excited only when a tone is sounded that resonates at its location. In this way, the ear acts as a frequency analyzer.

The researchers learned that signals from the apical end also distinguish voiced from whispered speech—in which we do not use our vocal cords. They also found that signals from mid-length convey quality, richness and sonority, and that only those from an area at the outer end provide intelligibility. They were able to further reduce the information sent to the brain from just the outer area and still get 95 percent intelligibility. The result was sort of a simplified whisper, proving that the ear extensively preanalyzes sound to lighten the load on the brain.—*B. F.*

What is the red shift, and how do astronomers determine the size of a red shift in the light from a distant celestial object like a quasar?

Astronomer Maarten Schmidt says a red shift is produced by a light source moving away from the observer, just as a blue shift is produced if the light source is approaching. The light waves from a receding source are stretched out, lengthened. The faster the object's motion away from the observer, the more its light waves are stretched and the greater the shift toward the redder end of the spectrum, where light waves are the longest.

Sound waves are affected similarly by motion. A train's horn is higher in pitch as it approaches (because the sound waves are shortened), and lower as it recedes (the sound waves are lengthened).

Now imagine a locomotive with ten horns on it, each with a different pitch. The tones of three horns, say, are too high in pitch for the human ear to detect—like the special dog whistles. Dogs can hear tones that are higher than 20,000 cycles per second but humans can't. If the train were moving fast enough, the sound waves of the normally inaudible horns would be stretched out enough to move into the audible range. We would hear them.

In determining the red shift of those mysterious objects commonly known as quasars, Dr. Schmidt explains the same sort of thing happened. For instance, the wavelengths of light from the quasar 3C-9 (see page 40) are three times longer than they would be if that quasar were at rest in relation to the earth. Each wavelength is represented by a spectral line which, normally, has a specific location in a spectrum. However, for 3C-9 a line normally located in a spectrum at 1,550 angstroms would, if the wavelength were three times as long, be located at the 4,650 angstrom mark. An angstrom is a very small unit of length, one angstrom being equal to one 254-millionth of an inch.—*D. C.*

COMMENT

How man will evolve

by Prof. Jean Hiernaux

MAN is unquestionably the spearhead of evolution, but he does not follow its course in the same way as did those forms which lived before him. It may be said that an evolutionary mechanism not previously in operation came into being with man. Before his coming, evolution was genetic in character. It consisted in changing the qualities inherited by the various species—in other words, changing the stock of genes borne by them. It had nothing to do with the will or with consciousness.

With the coming of man and, no doubt, as a necessary condition for his emergence, an entirely different evolutionary mechanism came into being and developed—the transmission from one individual to another and from one generation to the next of knowledge, inventions, and ways of life which are not inherited, and which can be perpetuated only through constant effort.

This is a less stable form of evolution, but it enables man to advance along the path of freedom and to gain control over his envi-

Reprinted from the UNESCO COURIER

ronment much more rapidly than he can through genetic evolution. This is probably the reason why, after a period of interaction between the two evolutionary mechanisms (lasting from the emergence of man, some two million years ago, until his appearance in his present form as "Homo sapiens" about 50,000 years ago), evolution towards a higher state now takes place essentially in the sphere of acquired ability, which we may call the cultural sphere.

There is no perceptible difference between the anatomical development of the skull of fossilized Homo sapiens and our skull, but man's control over the forces of nature has grown tremendously, and knowledge and techniques are progressing with ever-increasing speed. Cultural evolution has taken the place of genetic evolution.

If this explanation of the lack of change in the brain over tens of thousands of years is correct, we must not expect man in the future to have an enormous head. The brain he has now is large enough for him, and in any case he is already extending its range by means of electronic computers.

It is true that, judging by the bone-structure, "Homo sapiens" usually had coarser features in the stone age than today (as have the modern representatives of that cultural stage, the Australian aborigines). A certain refining of the bony projections has accompanied cultural evolution. Yet it is not to be expected that this trend will continue until the head is markedly different, the ridges of the brow may vanish, but the frontal bone cannot. There is also a tendency for the teeth to become smaller, and even for the third molar to be missing. Here again, there is no reason to think that this situation will ultimately produce a toothless human being. In any case, these processes are extremely slow compared with cultural evolution.

Genetic point of view

A process still in operation today in the genetic sphere, and there is no sign that it is nearing its end, is the modification of the inherited traits of populations so as to secure, from the genetic point of view, the best possible adaptation to a changing environment. Our adaptation to our environment, too, is increasingly cultural in character (take, for instance, our clothing, heating and air-conditioning), and advances in medicine are helping to lessen the importance of natural selection. We are constantly creating new environments (such as that of the great metropolises) which give rise to fresh biological problems. It will be a long time, no doubt, before cultural measures make genetic adapta-

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During Hugh Downs' extended vacation, his column will not appear. In its place, *Science Digest* presents a monthly column of comment by others. The author of this column is Prof. Jean Hiernaux, anthropologist and director of research at the National Centre of Scientific Research in Paris. He collaborates with the Institute of Sociology, Free University of Brussels, Belgium.

If an apparently unfavorable trait occurs frequently in a population, it is likely to be desirable in some respect presently unknown to us.

tion to local conditions unnecessary, and so put an end to it.

All that has been said so far concerns the spontaneous biological evolution of man. Now, man has acquired knowledge and technical ability which enable him to influence his inherited traits. The branch of science which deals with this process is eugenics. It is based on the theory that, for each inherited characteristic in which men differ from each other (such as the A, B and O blood groups, into which all individuals have been divided), there is a determining factor (a gene) which is the best of its kind, and which is found in all parts of the world.

Natural selection will tend to eliminate all alternatives except the best. If a new gene appears, as a result of mutations, either it will be better than the existing genes, and will supersede them, or else it will be weaker, and will be eliminated.

The aim of eugenics is to assist what is good in nature, by discouraging deleterious genes (through preventing individuals possessing them from reproducing) and by encouraging the best gene (for instance by advocating artificial insemination by semen which bears that gene). The tendency is, therefore, for eugenics to produce a human race composed of genetically identical individuals.

In many cases (when it is recessive), the elimination of a deleterious gene, even by total eugenics (the complete prevention of reproduction by those who bear it), requires many generations. Apart from this practical aspect, there is a serious argument against the general application of eugenics. Recent research has revealed that in very many cases natural selection does not move towards a state of uniformity through the elimination of all genes except one, but rather towards a state of balance between the frequencies of different genes.

Mankind has always exhibited considerable diversity in respect of many hereditary traits, which is a good thing. This is not only because the vitality of each population depends upon such diversity (or polymorphism), but because a gene may be beneficial in certain environmental conditions and harmful in others. We know of genes, for instance, a certain frequency of which is beneficial in malarial regions, but which are by no means desirable in other regions.

Men have settled in all parts of the globe. They live in widely differing natural environments which they are constantly modifying in ways that are not always predictable. This being so, the genetic ideal is to maintain diversity—the opposite of the aim of eu-

genics. Eugenics is unjustifiable except in so far as it can eradicate very serious hereditary diseases, of which there are few. If an apparently unfavourable trait occurs frequently in a population, it is very likely to be desirable in some respect at present unknown to us.

This criticism applies to positive eugenics, the object of which is to increase the number of "good" genes, as well as to negative eugenics, which aims to eradicate the "bad" ones; underlying both is the same ideal—uniformity. We have no reason to hope that a Superman will be produced in the eugenists' test-tubes. Any highly gifted beings they might produce would not constitute a biologically viable human race.

Realizing potential

We should do better to devote our energies to providing populations and individuals with living conditions in which their inherted potentialities can best be realized, rather than manipulating genes; and that is not eugenics, but what has been called euthenics.

There are hundreds of millions of human beings who, through hunger or disease, are prevented from realizing their physical potentialities as they would have done under better conditions. Differences between the intellectual achievements of the various human populations appear to be due entirely to the fact that their food, health and educational conditions are different. Euthenics opens up much broader and safer avenues for the betterment of mankind than does eugenics.

The processes in operation today —especially selection, which has the effect of differentiating populations by genetic adaptation to their living conditions, and cross-breeding, which produces greater homogeneity, while at the same time putting a premium on polymorphism—can, of themselves, produce the state which appears to meet the biological needs of our race, that is, unity in diversity. Individual adaptations are never very marked, and they are much less characteristic of man than his genetic capacity for general adaptation to varied conditions.

It would seem, therefore, that man is not destined to undergo any striking biological transformation through either spontaneous or induced evolution. He is, however, undergoing an ever more rapid cultural evolution. It took him hundreds of thousands of years—the palaeolithic era—to bring his stone-cutting technique to a moderately high standard, but only a few thousand years to advance from the stone age to the atomic age. It is in the sphere of cultural achievements that man can undergo a profound evolution which, though different in kind from genetic evolution, as we have seen, is moving in the same direction, and is the specifically human form of evolution.

This kind of evolution has become self-conscious. It is dependent upon man's desire to advance and

on the effectiveness of the measures he adopts to do so. It requires of men a sustained effort to improve, both as individuals and as a society. It does not appear to be necessarily inevitable. Our present state of knowledge, indeed, provided mankind with the means of total self-destruction.

Are we then justified in predicting that the cultural evolution will continue to progress? We may be somewhat prejudiced on the side of optimism, but not without reason. Under pressure of the forces of selection, the genetic evolution has gone on, passing through numerous phases, for over a thousand million years. In every case, the more complex, more highly developed form has supplanted the lower form when they have been present together and in a competitive situation.

Cultural invention

True mammals, for example, have supplanted marsupials in all parts of the world except Australia, where they have been but recently introduced. We may reasonably expect that by a similar mechanism a more highly-developed cultural form, when brought into contact with a less highly-developed one, will supersede it. Examples of this may be found in our past. One case is the extremely rapid expansion of the neolithic revolution, i.e. the invention of agriculture and cattle-breeding.

Biological evolutionary forces (using the word "biological" in the narrow sense) altered inherited traits, but cultural evolutionary forces preserve whatever is felt to be an incentive towards mankind's advancement. These include the desire for knowledge, which leads to scientific progress, and the desire of individuals and human societies to draw closer together, which impels us to love our neighbour, to feel ourselves involved in whatever affects mankind as a whole, and to strive for greater social justice for all mankind.

It is true that, as in the case of genetic evolution, these forces produce nothing more than trends, and do not exclude the possibility of periods of retrogression and partial failure. If we look at history from a sufficiently high vantage-point, it seems reasonable to think that they will succeed.

Where can this sort of evolution take mankind? In some fields, it is moving very quickly. Knowledge is advancing with great rapidity, and, amidst storm and stress, men are seeking for new forms of social morality consonant with their increasing awareness of their unity and of the interdependence of the elements of which the race is composed.

So, if we see the matter aright, we are advancing towards a Supermankind, and not towards Supermen. We may be unable at our stage in evolution to gain a complete picture of this future state, but already we know the paths that lead to it.

What psychiatry is about

I wish to congratulate your magazine on its continued coverage of psychiatric problems and advances ("Inside Psychiatry Today"). You could not have found more qualified persons to write the articles than Flora Schreiber and Melvin Herman.

It is very gratifying to me, after having been in this type of work for 30 years, to find more and more people interested in trying to find out what psychiatry is all about—and realizing that you "don't have to be crazy" to need help. We cannot expect to make advances in helping the emotionally ill unless we continue to wipe out the old "isolation" policy. The community must be brought into the picture, and your type of articles helps this to become a reality.

Keep up the good work!

Mrs. Mary D. Gould
Administrator
Chartes Oak Psychiatric Hospital
Covina, Calif.

Downs and Orwell

Hugh Downs's article, "60 Quadrillion is a Crowd" (April '65), gives me the impression that someone is good-humoredly making fun of us! I used to think George Orwell's "1984" was a grim and dismal picture of the future, but Dr. J. H. Fremlin, whom Downs quotes, makes Orwell look like a sissy.

Nevertheless, I am still putting my bets on Orwell. The physical limits on population, such as mass and heat disposal, are obvious things and easy to calculate. Orwell was counting on the limits of social adjustment. The doubling time for population is around 37 years; the factors handicapping social adjustment have a shorter doubling-time of 10 to 20 years.

My conclusion is that some sort of control over society, as well as population, had better start operating long before the second law of thermodynamics begins to take over.

Alfred B. Mason, M.D.
Rodman, Canal Zone

UFO's

Jacques Vallee's new book, "The Anatomy of a Phenomenon," was supposed to be the "Book in the News" being reviewed (June '65). It includes many important criticisms of scientific skeptics and the Air Force UFO project as well as of the UFO groups and cults. Instead of discussing the book on its merits, you use the opportunity to express your anti-UFO bias. The book attacks your position effectively; perhaps that is why you react so strongly to it.

Richard Hall, Acting Director
National Investigations Committee on Aerial Phenomena
Washington, D.C.

After reading Daniel Cohen's review of Jacques Vallee's book, I am aware of two things: one, that I shall buy a copy of Mr. Vallee's book and, two, that Mr. Cohen is not sufficiently qualified to write a review of any book on UFO's. His article not only

completely disregards the known facts in the encounters he mentions, but the title, "Should We Be Serious About UFO's?" is in direct contradiction to recent Air Force statements to the effect that UFO's are serious business and need to be rapidly identified.

GEORGE W. FAWCETT
Easton, Pa.

The answer to the question, "Should We Be Serious About UFO's?" is Yes! You say flying saucer publications are written like they are in another language. This is not true. Some UFO publications are written in a practical way. I'll admit there are some crackpots in the field but they are in the minority, not the majority.

JAMES M. DICKEY, Director
Windy Hills Saucer Society
Newark, Delaware

The article on UFO's has raised my ire primarily since it is obvious that the writer is not informed about the present status of UFOs. It's an outright disservice to your readers. You are supposed to keep your readers abreast with the happenings in science. But brushing aside the existence of UFO's shows how naive you can be.

ANDREW BLAGDON
Hollywood, Calif.

I have just finished reading Daniel Cohen's review entitled "Should We Be Serious about UFO's?" I have read some stupid, narrow-minded and prejudiced UFO articles in the past, but when it comes to twisting and distorting facts, I place him in the same class as the Air Force.

NICHOLAS NESTOR
Cleveland, Ohio

Your article "Should We Be Serious About UFO's?" was a disgrace to any "scientific" journal. Instead of trying to present a reasoned account of a complicated phenomenon, you attempt to reduce the subject to an aggregate of schoolboy pranks and science fiction neuroses. The United States Air Force has devoted twenty years and considerable expense to this investigation and obviously grants it far more importance than you do in your light-hearted dismissal.

STUART APPELLE
Pennsylvania
State University

The article "Should We Be Serious About UFO's?" was an excellent presentation of the case against UFO's. I am sure it was a source of satisfaction to those of your readers who agree with Mr. Cohen.

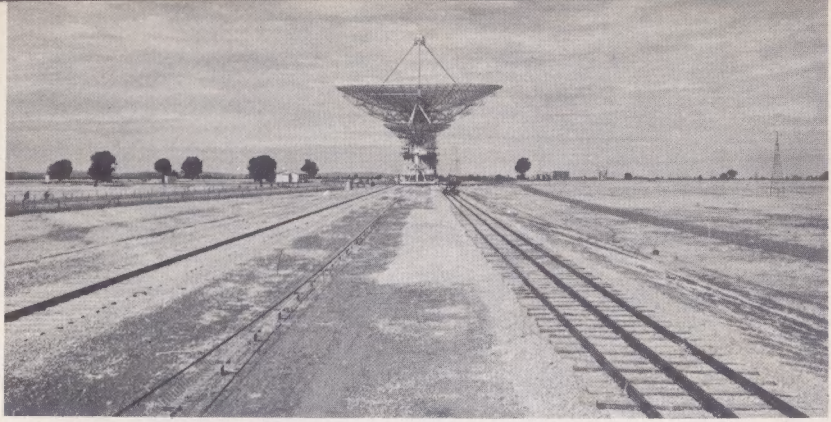
However, I am sure you also have a good many readers, like myself, who would be interested in reading the other side of the story and I hope, in fairness to the issue and to science, that in the near future *Science Digest* will print such an article.

CHARLES W. JOHNSON JR.
Haddam, Conn.

Not Morse code

At the risk of being considered either quibbling or pedantic, the writer wishes to point out that the telegraphic code depicted in "Science ABCs" the May '65 issue of your excellent and fascinating little journal is not the one that inventor Morse originated, but the standard radio communication code, known as the International.

CHARLES J. RUBEN
Los Angeles, Calif.



New 60-foot-diameter dish for probing radio sources in space moves along 1,400-foot rail tracks away from and toward partner, a 210-foot-diameter radio-telescope.

Looking up from down under

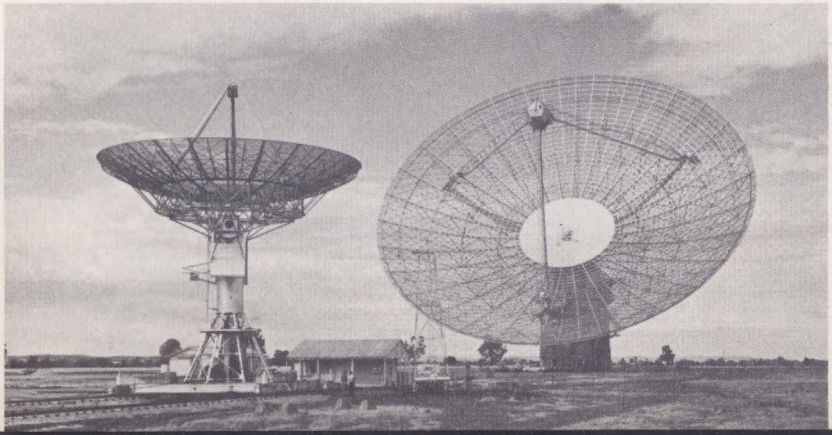
A 60-foot-diameter radio-telescope dish weighing 70 tons has been added to the giant 1,800-ton, 210-foot-diameter radio-telescope at Parkes, New South Wales, Australia. The new dish can be moved on rails to form an interferometer in association with the main radio-telescope.

The combination of the two instruments forms one of the most sophisticated pieces of equipment ever attempted by radio-astronomers, and will give a much more accurate position of a radio source in space, and an accurate angular structure of the source.

The 60-foot dish will run along rail tracks, self-propelled by a 7½ h.p. hydraulic motor. It will move at a maximum speed of 110 feet a minute and up to 1,400 feet away from the main telescope.

The big telescope, built at a cost of $1,638,000, can probe up to 10 billion light years into space.

The 210-foot radio-telescope, right, with the 60-footer that has just been erected will form one of the most sophisticated instruments in the field of radio-astronomy.



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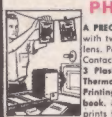

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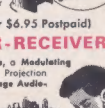

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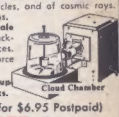

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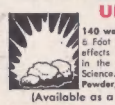

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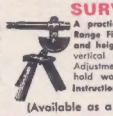

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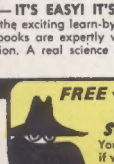

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